FINAL SUBMITTAL
REPORT, APPENDICES A THROUGH D

VOLUME I

ENERGY SAVINGS OPPORTUNITY SURVEY FORT MC PHERSON, GEORGIA

Prepared for

SAVANNAH DISTRICT
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

Under

CONTRACT NO. DACA21-91-C-0097

E M C ENGINEERS, INC.
Denver, Colorado
Atlanta, Georgia
Frankfurt, Germany

DEPARTMENT OF THE ARMY
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FINAL SUBMITTAL

VOLUME I OF II

ENERGY SAVINGS OPPORTUNITY SURVEY
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EMC ENGINEERS, INC.

ATLANTA, GEORGIA

This report has been prepared at the request of the client, and the observations, conclusions, and recommendations contained herein constitute the opinions of E M C Engineers, Inc. In preparing this report, EMC has relied on some information supplied by the client, the client's employees, and others, which we gratefully acknowledge. Because no warranties were given with this source of information, E M C Engineers, Inc. cannot make certification or give assurances except as explicitly defined in this report.

TABLE OF CONTENTS

Section | Page

VOLUME I

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF APPENDICES

TABLE OF CONTENTS (Continued)

LIST OF TABLES

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ACH	-	air changes per hour
AAFES	-	Army Air Force Exchange Service
AHU	-	air handling unit
Bldg	-	building
cfm	-	cubic feet per minute
conf.	-	confirmation
DCU	-	digital control unit
DDC	-	direct digital control
DEH	-	Director of Engineering and Housing
DHW	-	domestic hot water
DX	-	direct expansion
ECIP	-	Energy Conservation Investment Program
ECO(s)	-	Energy Conservation Opportunity(ies)
ESOS	-	energy savings opportunity survey
F	-	Fahrenheit
FCU	-	fan coil unit
ft	-	foot, feet
FY	-	fiscal year
gpm	-	gallons per minute
hp	-	horsepower
HPS	-	high pressure sodium
hr	-	hour(s)
HW	-	hot water
in.	-	inch(es)
kVar	-	kilovolt amp reactive
kW	-	kilowatt, one thousand watts
kWh	-	kilowatt-hour, one thousand watthours
LAPS	-	lighting automation panels
LBH	-	pounds per hour
lbm	-	pounds mass
LCCID	-	Life Cycle Cost in Design
MBtu	-	British thermal units (thousand)
mcf	-	thousand cubic feet

LIST OF ABBREVIATIONS
(Continued)

MCA	-	Military Construction Army Program
MCP	-	Military Construction Program
NAF	-	non-appropriated funds
PRV	-	pressure reducing valve
psia	-	pounds per square inch, absolute
psig	-	pounds per square inch, gauge
QRIP	-	Quick Return on Investment Program
RCU	-	remote control unit
rpm	-	revolutions per minute
SES	-	Shared Energy Savings
SIOH	-	supervision, inspection, and overhead
SIR	-	Savings-to-Investment Ratio
SOW	-	Scope of Work
therm	-	100,000 Btus
UCS	-	utility control system
UPW	-	uniform present worth

COMMANDER SUMMARY

PURPOSE OF STUDY

The purpose of the study was to analyze energy requirements and energy conservation opportunities (ECOs) for selected buildings at Fort McPherson, Georgia.

RESULTS

Of the individual ECOs evaluated, 14 ECOs had a savings-to-investment (SIR) ratio greater than 1.0. Those ECOs having an SIR greater than 1.0 are, by definition, economically feasible. The total estimated construction cost for the 14 ECOs is $1,500,675.

The individual ECOs were grouped into projects for possible funding under four main funding areas: 1) Energy Conservation Investment Program (ECIP); 2) Quick Return on Investment Program (QRIP); 3) Family Housing projects; and 4) Non-Appropriated Funds (NAF) projects, funded by agencies and organizations maintaining clubs, commissary, exchange, and related buildings.

At Fort McPherson, one project was evaluated for ECIP funding:

- ECO 1, Add duct insulation
- ECO 1, Add roof insulation
- ECO 1, Add pipe insulation
- ECO 7, Control hot water circulation pumps
- ECO 11, Replace street lights
- ECO 12, Revise or repair HVAC controls
- ECO 15, Lighting controls in Building 200
- ECO 18, Replace exit sign bulbs with fluorescent bulb kits
- ECO 19, Previous lighting study review, for light fixture replacement

ECO 8, install low flow shower and faucet fixtures, was evaluated as a QRIP project. ECO 16, one-way FM radio control of air-conditioning condensing units, was evaluated for Family Housing project funding. Three ECOs were evaluated for NAF facilities funding:

- ECO 1, Add pipe insulation
- ECO 7, Control hot water circulation pumps
- ECO 12, Revise or repair HVAC controls

Table 1 on the following page summarizes the savings, costs, and project economics of the proposed projects. It is recommended the Army fund and implement construction of the energy conservation projects to lower facility utility consumption in order to meet the energy reduction goals of Executive Order 12759 of April 17, 1991.

TABLE 1
ECONOMIC PROJECT SUMMARY

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND CREDIT ($)	NON-ENERGY SAVINGS ($)	TOTAL COST AVOID ($)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
ECIP	895	3,692,847	1,818	14,413	102,669	91,807	252	194,726	1,148,881	1.9	5.9
QRIP	0	0	1,001	1,001	4,675	0	6,495	11,170	10,956	12.4	1.0
FAMILY HOUSING	214	0	0	0	0	21,983	0	21,983	81,982	2.8	3.7
OTHER ENERGY PROJECT	69	311,397	(24)	1,039	7,828	7,196	0	15,024	192,644	1.2	12.8
NAF ECO-1	0	4	695	695	3,245	0	0	3,245	3,667	21.0	1.1
NAF ECO-7	0	33,679	378	493	2,624	0	0	2,624	11,003	3.2	4.2
NAF ECO-12	4	173,997	413	1,006	6,366	411	0	6,776	45,699	1.8	6.7
TOTAL	**1,182**	**4,211,924**	**4,281**	**18,647**	**127,407**	**121,397**	**6,747**	**255,548**	**1,494,832**		

EXECUTIVE SUMMARY

PURPOSE OF STUDY

This study was conducted under Contract No. DACA21-91-C-0097, issued by the Corps of Engineers, Savannah District, in September 1991. The study analyzes energy requirements and energy conservation opportunities (ECOs) for selected buildings at Fort McPherson, Georgia.

ECOs EVALUATED

The 17 ECO projects identified in the SOW to be evaluated for selected buildings are listed in Table ES-1 on page ES-2.

During the entrance interview conference, ECO 18 was included. ECO 18, which converts incandescent exit sign light bulbs to fluorescent bulbs, was evaluated for all buildings specified for ECO 15, lighting controls.

Based on discussions with DEH, it was also decided to include the results of previous lighting studies (see Section 1.6), which were originally evaluated as shared energy savings projects. The results are included as ECO 19; economics are based on design, bid, and construction, direct by the Government, rather than by an energy service contractor under a shared energy savings contract.

Subsequent to the field survey, each ECO for each building was reviewed to determine if it was technically feasible. ECOs which are not technically feasible were eliminated from further evaluation. A complete list of these ECOs, and the reasons they were eliminated, are included in Table ES-2 on page ES-3.

In addition, as the facilities were surveyed, some ECOs included in the SOW were found to apply to buildings not identified in the ECO matrix (Annexes B and C). With the approval of DEH, these buildings were added to the original list.

Table ES-3 on page ES-5 contains a building-ECO matrix, indicating which ECOs are:

- Applicable and evaluated projects
- Not applicable and dropped from further evaluation
- Added as an applicable project.

TABLE ES-1
ENERGY CONSERVATION OPPORTUNITY LIST

ECO NUMBER	ECO DESCRIPTION
1	Insulate Walls, Roofs, Pipes, and Ducts
2	Insulate Windows
3	Weatherstripping and Caulking
4	Domestic Hot Water Temperature (Measurement Only)
5	Install High Efficiency Electric Motors
6	Economizers
7	Control Hot Water Circulation Pump
8	Install Low-flow Shower and Faucet Fixtures
9	Heat Reclaim from Hot Refrigerant Gas
10	Prevent Air Stratification
11	Replace Street Lights
12	Revise or Repair HVAC Controls
13	Thermal Storage
14	Radiant Heaters and Loading Dock Seals
15	Separate Light Switches
16	Investigate Post Demand Usage
17	Boiler Operation Schedule
18	Replace Exit Sign Bulbs with Fluorescent Bulb Kit
19	Previous Lighting Review Study

TABLE ES-2
NONFEASIBLE ECOs

BLDG. NO.	ECO NO.	REASON ECO NONFEASIBLE
22	1	Has adequate insulation
	2	Has double pane windows
	8	Has low-flow fixtures
	12	Has adequate controls for HVAC
27	1	Has adequate insulation
	2	Has double pane windows
28	1	Has adequate insulation
	2	Has double pane windows
40	1	Has adequate insulation
41	1	Has adequate roof insulation
41	2	Has double pane windows
42	1	Has adequate wall, roof, and pipe insulation
61	1	Has adequate insulation
100	1	Has adequate insulation
	2	Has double pane windows
101	1	Has adequate insulation
102	1	Has adequate wall, roof, and pipe insulation
	3	Has adequate caulking and weatherstripping
105	1	Has adequate wall, roof, and pipe insulation
	2	Has double pane windows
109	1	Has adequate wall, roof, and duct insulation
117	4	No DHW in building
131	6	Building has openable windows, thus economizers are not required
155	1	Has adequate insulation
170	6	Building has openable windows, thus economizers are not required
171	6	Building has openable windows, thus economizers are not required

TABLE ES-2
NONFEASIBLE ECOs
(Concluded)

BLDG. NO.	ECO NO.	REASON ECO NONFEASIBLE
178	1	Has adequate insulation
	2	Has double pane windows
	3	Has adequate weatherstripping and caulking
179	1	Has adequate insulation
	2	Has double pane windows
	3	Has adequate weatherstripping and caulking
181	2	Has double pane windows
184	1	Has adequate insulation
187	13	Building too small for thermal storage
200	9	Has heat reclaim
206	7	Existing controls are new and in excellent condition
250	12	Has adequate controls for HVAC
358	1	Has adequate insulation
	2	Has double pane windows
360	14	Has air curtains and unit heaters; loading dock seals are not applicable
	10	Building being remodeled such that air stratification will not occur
400	1	Has adequate wall, roof, and pipe insulation
	2	Has double pane windows
	3	Has adequate caulking and weatherstripping
522	1	Has adequate wall, roof, and duct insulation
	2	Has double pane windows
27, 28, 102, 105, 109, 111-126, 178, 179, 187, 250, 366	5	No motors over 1 horsepower
General	17	This ECO applied to buildings at Fort Gillem, only

TABLE ES-3
BUILDING ECO MATRIX

BLDG #	DESCRIPTION	ECO NUMBER																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
022	Administration	N	N	A	A	A			N				N				A			A*
027	Guest	N	N	A	A	N			A								A			A*
028	Guest	N	N	A	A	N			A								A			A*
040	UPH	N	A	A	A	A			A								A			A*
041	Administration	A	N	A	A	A										A	A		A*	A*
042	Chapel	A	A	N	A	A											A			A*
056	UPH		A*	A*	A	A			A				A			A	A		A*	A*
058	UPH		A*	A*	A	A			A				A			A	A		A*	A*
060	UPH		A*	A*	A	A			A				A	A*		A	A		A*	A*
061	Mess Hall/Lab	N	A	A	A	A											A			A*
062	UPH				A	A			A				A			A	A		A*	A*
100	Dental	N	N	A	A	A							A*				A			A*
101	Dental	N	A	A	A	A							A			A	A		A*	A*
102	Police	A	A	N	A	N											A			A*
105	Lab	A	N	A	A	N											A			A*
109	Guest	A	A	A	A	N			A								A			A*
111	Administration	A	A	A	A	N											A			A*

A - Applicable and evaluated project
N - Not applicable and dropped from further analysis
A* - Added as an applicable project

TABLE ES-3
BUILDING ECO MATRIX

BLDG #	DESCRIPTION	ECO NUMBER																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
112	Administration	A	A	A	A	N											A			A*
114	Administration	A	A	A	A	N											A			A*
116	Administration	A	A	A	A	N											A			A*
117	Classroom	A	A	A	N	N											A			A*
118	Administration	A	A	A	A	N											A			A*
120	Administration	A	A	A	A	N											A			A*
121	Administration	A	A	A	A	N											A			A*
122	Administration	A	A	A	A	N											A			A*
124	Administration	N	A	A	A	N											A			A*
126	Administration	A	A	A	A	N											A			A*
131	Administration				A	A	N						A*				A			A*
155	NCO Club	A	A	A	A	A											A			A*
168	Admin. (VOQ)	A*			A	A			A				A				A			A*
170	Hospital				A	A	N	A		A			A*	A*		A	A		A*	A*
171	Hospital				A	A	N	A		A			A*	A*		A	A		A*	A*
178	Training	N	N	N	A	N											A			A*
179	Classroom	N	N	N	A	N											A			A*

A - Applicable and evaluated project
N - Not applicable and dropped from further analysis
A* - Added as an applicable project

TABLE ES-3
BUILDING ECO MATRIX

BLDG #	DESCRIPTION	ECO NUMBER																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
181	Administration	A	N	N	A	A	A*			A			A	A*		A	A		A*	A*
184	Storage	N	A	N	A	A	A	A					A	A*		A	A		A*	A*
187	PX Maintenance				A	N								N			A			A*
200	Administration				A	A				N			A*	A		A*	A		A*	A*
206	Administration				A	A		N									A			A*
246	Administration				A	A	A						A	A		A	A		A*	A*
250	Library				A	N							N				A			A*
358	Administration	N	N	A	A	A	N						A				A			A*
360	Commissary	A*			A	A				A					N		A			A*
363	Maintenance				A	A			A*							A	A		A*	A*
366	Storage				A	N					A				N	A	A		A*	A*
400	Moral Support	N	N	N	A	A										A	A		A*	A*
401	Bowling				A	A			A*							A	A		A*	A*
500	Dining Facility				A	A	N	A		A			A	A*			A			A*
514	Day Care				A	A	A						A*				A			A*
522	Guest	N	N	A	A	A				A							A			A*

A - Applicable and evaluated project
N - Not applicable and dropped from further analysis
A* - Added as an applicable project

RESULTS

Of the individual ECOs evaluated, 14 projects had an SIR greater than 1.0 (see Table ES-5 on page ES-11). Those ECOs having an SIR greater than 1.0 are by definition economically feasible. The total estimated construction cost for the 14 projects is $1,500,675.

Table ES-4 on page ES-9 lists the economic summary of each individual ECO, in ECO number order. Table ES-5 on page ES-11 lists the economic summary of each individual ECO, in order by SIR.

All ECOs determined to have an SIR less than 1.0 should be dropped from further analysis. These include:

- ECO 1, Wall Insulation
- ECO 2, Insulated Windows
- ECO 6, Economizers
- ECO 9, Heat Reclaim from Hot Refrigerant Gas
- ECO 10, Prevent Air Stratification
- ECO 13, Thermal Storage

TABLE ES-4
ECONOMIC SUMMARY OF ECOs, LISTED BY ECO NUMBER

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND CREDIT ($)	NON-ENERGY SAVINGS ($)	TOTAL COST AVOID ($)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
1-Wall Insulation		NO BUILDINGS WITH SIR GREATER THAN 1.0									
1-Roof Insulation	4	3,164	51	62	318	406	0	724	3,791	3.4	5.2
1-Duct Insulation	0	29,656	243	345	1,893	0	0	1,893	9,625	4.0	5.1
1-Pipe Insulation	0	24	880	880	4,110	0	0	4,110	10,717	9.1	2.6
2-Insulate Window		NO BUILDINGS WITH SIR GREATER THAN 1.0									
3-Caulking	2	22	1	1	5	234	0	240	1,485	2.4	6.2
4-HW Temp		NOT APPLICABLE - MEASUREMENT ONLY									
5-High Eff. Motor	54	264,518	0	902	6,745	5,594	0	12,339	162,986	1.1	13.2
6-Economizer		NO BUILDINGS WITH SIR GREATER THAN 1.0									
7-HW Pump Control	0	128,957	876	1,316	7,379	0	0	7,379	33,008	2.9	4.5
8-Shower/Faucet	0	0	1,001	1,001	4,674	0	6,495	11,169	10,956	12.4	1.0
9-Heat Reclaim		NO BUILDINGS WITH SIR GREATER THAN 1.0									
10-Air Stratification		NO BUILDINGS WITH SIR GREATER THAN 1.0									
11-Street Lights	0	43,362	0	148	1,111	0	417	1,527	6,917	3.4	4.5
12-HVAC Controls	93	1,380,662	1,386	6,094	41,678	9,505	1,143	52,327	273,301	2.2	5.2
13-Thermal Storage		NO BUILDINGS WITH SIR GREATER THAN 1.0									
14-Dock Seals		NOT APPLICABLE									
14-IR Heaters		NOT APPLICABLE									

TABLE ES-4
ECONOMIC SUMMARY OF ECOs, LISTED BY ECO NUMBER

(CONCLUDED)

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND CREDIT ($)	NON-ENERGY SAVINGS ($)	TOTAL COST AVOID ($)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
15-Light Control B200	163	761,510	0	2,599	19,419	16,734	0	36,152	142,464	3.8	3.9
15-Light Control	13	46,857	(25)	135	1,077	1,368	0	2,445	28,173	1.3	11.5
16-Demand	214	0	0	0	0	21,983	0	21,983	81,982	3.4	4.5
17-Boiler		NOT APPLICABLE									
18-Exit Sign	12	102,755	0	351	2,631	1,204	(1,181)	2,654	16,567	2.5	6.2
19-Lighting Retrofit	627	1,467,180	0	5,003	37,413	64,368	0	101,781	718,703	2.1	7.1

TABLE ES-5
ECONOMIC SUMMARY OF ECOs, LISTED BY SIR

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND CREDIT ($)	NON-ENERGY SAVINGS ($)	TOTAL COST AVOID ($)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
8-Shower/Faucet	0	0	1,001	1,001	4,674	0	6,495	11,169	10,956	12.4	1.0
1-Pipe Insulation	0	24	880	880	4,110	0	0	4,110	10,717	9.1	2.6
1-Duct Insulation	0	29,656	243	345	1,893	0	0	1,893	9,625	4.0	5.1
15-Light Control B200	163	761,510	0	2,599	19,419	16,734	0	36,152	142,464	3.8	3.9
1-Roof Insulation	4	3,164	51	62	318	406	0	724	3,791	3.4	5.2
11-Street Light	0	43,362	0	148	1,111	0	417	1,527	6,917	3.4	4.5
7-HW Pump Control	0	128,957	876	1,316	7,379	0	0	7,379	33,008	2.9	4.5
16-Demand	214	0	0	0	0	21,983	0	21,983	81,982	2.8	3.7
18-Exit Sign	12	102,755	0	351	2,631	1,204	(1,181)	2,654	16,567	2.5	6.2
3-Caulking	2	22	1	1	5	234	0	240	1,485	2.4	6.2
12-HVAC Controls	93	1,380,662	1,386	6,094	41,678	9,505	1,143	52,327	273,301	2.2	5.2
19-Lighting Retrofit	627	1,467,180	0	5,003	37,413	64,368	0	101,781	718,703	2.1	7.1
15-Light Control	13	46,857	(25)	135	1,077	1,368	0	2,445	28,173	1.3	11.5
5-High Eff. Motor	54	264,518	0	902	6,745	5,594	0	12,339	162,986	1.1	13.2
TOTAL	**1,183**	**4,228,667**	**4,413**	**18,837**	**128,453**	**121,396**	**6,874**	**256,723**	**1,500,675**	**2.7**	**5.8**
4-HW Temp		NOT APPLICABLE - MEASUREMENT ONLY									
2-Insulate Window		NO BUILDINGS WITH SIR GREATER THAN 1.0									
1-Wall Insulation		NO BUILDINGS WITH SIR GREATER THAN 1.0									

TABLE ES-5
ECONOMIC SUMMARY OF ECOs, LISTED BY SIR

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND CREDIT ($)	NON-ENERGY SAVINGS ($)	TOTAL COST AVOID ($)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
9-Heat Reclaim		NO BUILDINGS WITH SIR GREATER THAN 1.0									
6-Economizer		NO BUILDINGS WITH SIR GREATER THAN 1.0									
17-Boiler		NOT APPLICABLE									
14-IR Heaters		NOT APPLICABLE									
10-Air Stratification		NO BUILDINGS WITH SIR GREATER THAN 1.0									
14-Dock Seals		NOT APPLICABLE									
13-Thermal Storage		NO BUILDINGS WITH SIR GREATER THAN 1.0									

ENERGY PROJECT DEVELOPMENT

Individual ECOs were grouped into projects for possible funding under four main funding areas:

- Energy Conservation Investment Program (ECIP) projects
- Non-ECIP, including Quick Return on Investment Program (QRIP), Military Construction Army (MCA) program, and low-cost/no-cost projects
- Family Housing Projects, funded by housing program budgets
- Non-Appropriated Funds (NAF) Projects, funded by agencies and organizations maintaining clubs, commissary, exchange, and related buildings.

Following the Interim Submittal, Fort McPherson DEH provided EMC with a list of buildings which have reimbursed utilities (NAF buildings), plus buildings which are to be torn down in the near future. These facilities were eliminated from the ECO projects. Elimination of these facilities required the ECIP projects recommended in the Interim Submittal to be revised to take into account lower individual ECO construction cost estimates.

At Fort McPherson, one project was evaluated for ECIP funding:

- ECIP Project, including the following ECOs:

  - ECO 1, Add pipe insulation
  - ECO 1, Add roof insulation
  - ECO 1, Add duct insulation
  - ECO 7, Control hot water circulation pumps
  - ECO 11, Replace street lights
  - ECO 12, Revise or repair HVAC controls
  - ECO 15, Lighting controls in Building 200
  - ECO 18, Replace exit signs bulbs with fluorescent bulb kits
  - ECO 19, Previous lighting study review, for light fixture replacements.

One project was evaluated for QRIP funding:

- QRIP Project - ECO 8, Install low-flow shower and faucet fixtures.

One project at Fort McPherson was evaluated for funding by housing program budgets:

- Housing Project - ECO 16, One-way FM radio control of air-conditioning condensing units.

ECOs evaluated for NAF facilities which have an SIR greater than 1.0 and a simple payback less than 8 years, were lumped together for consideration by NAF related organizations.

Three energy projects evaluated for Fort McPherson, did not qualify for ECIP or Non-ECIP funding. Fort McPherson should consider funding these projects through other funding avenues, such as operations and maintenance budgets. These ECOs include:

- ECO-3, Weatherstripping and caulking
- ECO-5, Install high efficiency electric motors
- ECO-15, Separate (automatic) light switches

Table ES-6 on page ES-15 provides an economic summary of projects which should be considered for funding. Overall, there are $1,148,881 of potential ECIP projects, $92,938 of Non-ECIP projects, $60,369 of NAF projects, and $192,644 of other energy projects to fund.

TABLE ES-6
ECONOMIC PROJECT SUMMARY

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND CREDIT ($)	NON-ENERGY SAVINGS ($)	TOTAL COST AVOID ($)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
ECIP	895	3,692,847	1,818	14,413	102,669	91,807	252	194,726	1,148,881	1.9	5.9
QRIP	0	0	1,001	1,001	4,675	0	6,495	11,170	10,956	12.4	1.0
FAMILY HOUSING	214	0	0	0	0	21,983	0	21,983	81,982	2.8	3.7
OTHER ENERGY PROJECT	69	311,397	(24)	1,039	7,828	7,196	0	15,024	192,644	1.2	12.8
NAF ECO-1	0	4	695	695	3,245	0	0	3,245	3,667	21.0	1.1
NAF ECO-7	0	33,679	378	493	2,624	0	0	2,624	11,003	3.2	4.2
NAF ECO-12	4	173,997	413	1,006	6,366	411	0	6,776	45,699	1.8	6.7
TOTAL	**1,182**	**4,211,924**	**4,281**	**18,647**	**127,407**	**121,397**	**6,747**	**255,548**	**1,494,832**		

RECOMMENDATIONS

- It is recommended the Army fund the construction of the ECIP Project to lower facility utility consumption in order to meet energy reduction goals of the Department of Defense.

- It is recommended the Army fund construction of the QRIP Project and Housing Project to lower facility utility consumption in order to meet energy reduction goals of the Department of Defense.

- It is recommended the results of the energy evaluations on NAF buildings be provided to the related organizations for possible funding.

ENERGY CONSUMPTION

Electricity, natural gas, and water and sewer use will be conserved if the ECOs identified in this study are implemented.

Electrical energy consumption for FY90 and FY91 is tabulated in Table ES-7 on page ES-17. The average monthly electrical consumption varies from a minimum of 2,725,200 kWh in November, to a maximum of 4,348,800 kWh in August. Electrical consumption for Building 200 is 32% of the total electrical energy used at Fort McPherson. The electrical consumption of Building 200 for FY90 and FY91 is also presented in Table ES-7 for information purposes.

Natural gas consumption for FY90 and FY91 is tabulated in Table ES-8 on page ES-18. The average monthly natural gas consumption varies from a minimum of 13,718 therms in August, to a maximum of 155,068 therms in January.

TABLE ES-7
ELECTRICAL ENERGY CONSUMPTION
FORT MC PHERSON

Month	Post-wide Electrical Consumpt. kWh, FY90	Post-wide Electrical Consumpt. kWh, FY91	Bldg. 200 Electrical Consumpt. kwh, FY90	Bldg. 200 Electrical Consumpt. kWh, FY91	Post-wide Electrical Consumpt. kWh Avg.90/91	Bldg. 200 Electrical Consumpt. kWh Avg.90/91
Oct.	2,966,400	3,290,400	1,163,200	1,298,400	3,128,400	1,230,800
Nov.	2,512,800	2,937,600	1,328,800	1,262,400	2,725,200	1,295,600
Dec.	3,081,600	2,865,600	1,206,400	1,217,600	2,973,600	1,212,000
Jan.	3,441,600	2,844,000	1,155,200	1,152,800	3,142,800	1,154,000
Feb.	2,577,600	2,844,000	1,207,200	1,295,200	2,710,800	1,251,200
March	2,937,600	2,671,200	1,044,000	1,100,000	2,804,400	1,072,000
April	2,620,800	3,110,400	1,046,400	1,315,200	2,865,600	1,180,800
May	3,088,800	3,038,400	1,128,000	1,113,600	3,063,600	1,120,800
June	3,686,400	3,513,600	1,188,800	1,274,400	3,600,000	1,231,600
July	3,801,600	4,226,400	1,163,200	1,449,600	4,014,000	1,306,400
Aug.	4,471,200	4,226,400	1,269,600	1,240,800	4,348,800	1,255,200
Sept.	3,672,000	3,607,200	1,590,400	993,600	3,639,600	1,292,000
TOTAL	38,858,400	39,175,200	14,491,200	14,713,600	39,016,800	14,602,400

TABLE ES-8
NATURAL GAS CONSUMPTION
FORT MC PHERSON

Month	Post-wide Natural Gas Consumption (Therms - FY90)	Post-wide Natural Gas Consumption (Therms - FY91)	Post-wide Natural Gas Consumption (Therms - Avg.)
Oct.	40,565	33,899	37,232
Nov.	69,750	71,820	70,785
Dec.	128,769	117,323	123,046
Jan.	147,128	163,007	155,068
Feb.	113,588	122,905	118,247
March	93,751	99,507	96,629
April	57,239	30,242	43,741
May	19,608	16,032	17,820
June	15,426	13,597	14,512
July	14,101	12,819	13,460
Aug.	13,957	13,479	13,718
Sept.	15,100	13,974	14,537
TOTAL	728,982	708,604	718,793

The percentage comparison of historical consumption and costs for electricity and natural gas is tabulated in Table ES-9 below. Table ES-10 below provides a comparison of the percent of energy and dollars saved after the ECOs recommended are implemented.

TABLE ES-9
FY91 UTILITY USAGE AND COST COMPARISON

UTILITY	CONSUMPTION FY91		COST FY91	
	(MBtu)	(%)	($)	(%)
Electricity	133,705	65	1,897,111	82
Natural Gas	70,860	35	421,996	18
Total	204,565	100	2,319,107	100

TABLE ES-10
PERCENT ENERGY AND DOLLAR SAVINGS

UTILITY	ENERGY SAVINGS			DOLLAR SAVINGS		
	Base Energy (MBtu)	Energy Savings (MBtu)	Percent Savings (%)	Base Energy ($)	Energy Savings ($)	Percent Savings (%)
Electricity	133,705	14,375	10.8	1,897,111	107,381	5.7
Natural Gas	70,860	4,281	6.0	421,996	19,992	4.7
Total	204,565	18,656	9.1	2,319,107	127,374	5.5

SECTION 1.0

INTRODUCTION

1.1 AUTHORITY FOR STUDY

This study was conducted under Contract No. DACA21-91-C-0097, issued by the U.S. Army Corps of Engineers, Savannah District, in September 1991.

1.2 PURPOSE OF STUDY

The purpose of the study was to analyze energy requirements and energy conservation opportunities (ECOs) for selected buildings at Fort McPherson, Georgia.

1.3 SCOPE OF WORK

The scope of work (SOW) for this study, dated 18 June 1991, is entitled "Energy Savings Opportunity Survey" (ESOS), and includes the following major tasks:

- Conduct a limited site survey to evaluate the ECOs in the selected buildings.
- Obtain the necessary data to evaluate.
- Identify which ECOs are technically feasible, including low cost or no cost ECOs.
- Calculate the energy and dollar savings, and prepare cost estimates for each ECO determined to be technically feasible.
- Calculate the simple payback and savings-to-investment ratio (SIR) for each ECO.
- Prepare an Interim Submittal which illustrates the methods, justifications, and calculations of the approaches taken.
- Present, at a review conference, the work accomplished to date, showing energy and dollar savings, simple payback, and SIR of all technically feasible ECOs.
- Combine technically and economically feasible ECOs into larger packages (in coordination with installation personnel) which will qualify for Energy Conservation Investment Program (ECIP) or Military Construction Program (MCP) funding.

The complete SOW for this study and related Confirmation Notices are included in Appendix A of this Volume I. For convenience, Table 1-1, starting on page 1-4, presents a detailed list of items required by the SOW and indicates where those items are presented in this report.

1.4 ORGANIZATION OF SUBMITTAL

Volume I of this submittal includes the following:

- Sections 1.1 and 1.2 contain introductory information relevant to the study and the preparation of the report, based on the SOW outlined in Section 1.3. This Section 1.4 explains the organization of the report, while Section 1.5 describes the status of the study and the work remaining to complete the project. Section 1.6 describes previous energy studies at Fort McPherson.

- Section 2.0 describes the Fort McPherson utility rates and energy use for FY90 and FY91.

- Section 3.0 describes the ECOs evaluated, the analysis methodology, and the results of the ECO evaluations.

- Section 4.0 describes recommended energy conservation projects for future funding.

- Section 5.0 presents a summary of findings and recommendations.

- Appendices A through D provide backup calculations and contract documentation.

Volume II of this submittal includes the following:

- Appendix E includes computer simulations.

- Appendix F includes field survey notes.

1.5 WORK ACCOMPLISHED

With the completion of this Final Submittal, the following items have been accomplished:

- Site survey.

- Entrance and exit interviews.

- Determination of base energy usage.

- Evaluation of ECOs.

- Calculation of ECO cost, annual energy savings, annual dollar savings, SIR, and simple payback period.

- Prioritization of ECOs by SIR.

- Preparation and delivery of Interim Submittal.
- Interim Submittal review conference.
- Update ECO projects, based on review comments.
- Combine technically and economically feasible ECOs into packages (in coordination with installation personnel) which will qualify for ECIP or MCP funding.
- Determine cost, annual energy savings, annual dollar savings, SIR, and simple payback period of the ECO packages.
- Prepare and deliver Prefinal Submittal.
- Prefinal Submittal review conference.
- Make revisions and corrections.
- Conduct an O&M briefing of the study results.
- Prepare and deliver Final Submittal.

TABLE 1-1
SCOPE OF WORK SUMMARY
ENERGY SAVINGS OPPORTUNITY SURVEY, FORT McPHERSON, GEORGIA

ITEM NO.	SOW PAGE	SOW SECTION	DESCRIPTION	VOLUME SECTION
1	1 5	1.1 7.2	Perform limited site survey.	--
2	1	1.2	Evaluate ECOs to determine economic feasibility.	Volume I 3.0
3	1 6	1.3 7.3	Group recommended ECOs into projects for implementation.	Volume I 4.0
4	1	1.4	Prepare submittal.	-
5	1	2.3	As a minimum, evaluate ECOs listed in Annex A.	Volume I 3.2
6	2 5	2.3 7.2	Determine if ECOs are technically feasible. Document ECOs considered not feasible.	Volume I 3.2
7	2 5	2.6 7.1	Use current ECIP criteria in performing analysis.	Volume I 3.4
8	2	2.7	Combine ECOs into larger packages for ECIP or MCP funding.	Volume I 4.0
9	2	2.7.1	List and prioritize, by SIR, projects which qualify for ECIP funding.	Volume I Table 3-32
10	2	2.7.2	Prioritize, by SIR, feasible non-ECIP projects.	Volume I Table 4.3
11	4 5	5.1 7.1	Develop life cycle cost analysis summary sheets for ECIP projects.	Volume I Appendix C
12	4	5.1	Provide original backup calculations from previous studies.	Volume I Appendix C
13	4	5.2	Develop life cycle cost analysis summary sheets for non-ECIP projects.	Volume I Appendix D
14	4	5.3	Document nonfeasible ECOs in the report.	Volume I 3.2
15	5	7.1	Analyze the ECOs listed in Annex A.	Volume I 3.4

TABLE 1-1
SCOPE OF WORK SUMMARY (Continued)
ENERGY SAVINGS OPPORTUNITY SURVEY, FORT McPHERSON, GEORGIA

ITEM NO.	SOW PAGE	SOW SECTION	DESCRIPTION	VOLUME SECTION
16	6	7.1.2	Prepare calculation, showing all numbers and assumptions.	Volume I Appendix C
17	5	7.1	Utilize computer simulations on specified ECOs.	Volume I Appendix C
18	5	7.2	Document site survey, and provide completed forms as part of the report.	Volume II Appendix F
19	5	7.2	Thoroughly evaluate and document all potential ECOs which are not eliminated.	Volume I Appendix C
20	6 Conf. Notice 2	7.4 No. 8	Prepare a comprehensive report.	Prefinal Submittal
21	6	7.4	Give a formal presentation of the results.	--
22	6	7.4.1	Interim Submittal - include analyses performed to date and results of field survey.	Interim Submittal
23	6	7.4.1	Interim Submittal - include copies of the Scope of Work and any modifications.	Volume I Appendix A
24	6	7.4.1	Interim Submittal - provide a narrative summary.	Executive Summary
25	6	7.4.1	Interim Submittal - include copies of field survey forms.	Volume II Appendix F
26	7 Conf. Notice 2	7.4.2 No. 5	Prefinal Submittal - document the integrated aspects of the study.	Volume I 4.0
27	7	7.4.2	Prefinal Submittal - include an order of priority, by SIR, for the recommended ECOs.	Volume I 4.0

TABLE 1-1
SCOPE OF WORK SUMMARY (Concluded)
ENERGY SAVINGS OPPORTUNITY SURVEY, FORT McPHERSON, GEORGIA

ITEM NO.	SOW PAGE	SOW SECTION	DESCRIPTION	VOLUME SECTION
28	7	7.4.2	Prefinal Submittal - include an executive summary per Annex D.	Executive Summary
29	7	7.4.2	Prefinal Submittal - list all projects and ECOs developed in the study.	Volume I 4.0
30	7	7.4.3	Final Submittal - incorporate revisions and corrections resulting from comments.	Final Submittal
31	5	7.2	Use metering equipment with the proper accuracies and calibration.	Volume II Appendix F
32	E-1	--	Present an operational and maintenance briefing.	--
33	--	--	Computer simulation printouts will be provided.	Volume II Appendix E

1.6 PREVIOUS UTILITY CONSERVATION STUDIES

During the course of this ESOS study, EMC reviewed a number of utility conservation studies completed by other firms for Fort McPherson. These studies include:

- "Feasibility Analysis For A Shared Energy Savings Lighting Retrofit in Building 200, At Ft. McPherson," prepared by Pacific Northwest Laboratory, January 1991.
- "Test Report for Ft. McPherson, Building 200 Electrical Usage Evaluation," prepared by Pacific Northwest Laboratory, July 1991.
- "Feasibility Study For Lighting Shared Energy Savings Project, Ft. McPherson and Ft. Gillem," prepared by Stone & Webster Engineering Corporation, July 1990.
- "Basewide Energy Systems Plan For Ft. Gillem," prepared by JRB Associates, July 1980.
- "Energy Conservation Opportunity (ECO) Evaluation," prepared by Tennessee Valley Authority, May 1989.

The results of the two shared energy savings lighting retrofit projects were reevaluated and incorporated in this study (see Section 3.4.19). Where practical, some technical information presented in these reports was utilized in the preparation of this report.

SECTION 2.0

UTILITY CONSUMPTION AND RATES

2.1 GENERAL

Fort McPherson is located in the Atlanta, Georgia, metropolitan area, approximately four miles southwest of downtown Atlanta. The post occupies 505 acres of land, with most of the buildings located on half this area. As Fort McPherson was established in 1884, many of the existing buildings have historical significance and are placed in the National Register.

Electricity, natural gas, and water and sewer use can be conserved by the ECOs evaluated in this study. The rates and historical consumption of these utility sources are discussed in this Section.

Fuel oil is currently used as a backup fuel when Atlanta Gas Light, the local natural gas utility company, requires Fort McPherson to interrupt natural gas usage. For the purposes of this study, only the usage and cost for natural gas were considered for the economic evaluations, because fuel oil consumption has been negligible.

Backup calculations are provided in Appendix B of this Volume I.

2.2 UTILITY RATES

2.2.1 Electrical Rates

Electrical energy is supplied to Fort McPherson under Schedule G-10, <u>Full Use Service to Government Institutions</u>, from Georgia Power Company. The current rates and contracted amounts have been in effect since 4 December 1991. The electrical rate is broken down into five parts, as follows:

- Base charge
- Consumption (energy) charge
- Power factor charge
- Fuel cost recovery charge
- Minimum monthly billing.

<u>Base Charge:</u> The base charge is $55 per month.

<u>Consumption charge:</u>

kWh less than 300 x billing demand	
Cost of first 50,000 kWh	$0.0600 per kWh
Cost of next 150,000 kWh	$0.0582 per kWh

Cost of next 800,000 kWh	$0.0442 per kWh
Cost of over 1,000,000 kWh	$0.0410 per kWh
kWh more than 300 x billing demand	$0.0115 per kWh.

Billing demand is greatest of:

(1) Current monthly actual demand
(2) 95% of highest demand in previous June through September
(3) 60% of highest demand in previous October through May.

Power factor charge:

Power factor < 95% $0.27 per kVAR.

Currently, the power factor is above 95% and there has been no charge.

Fuel cost recovery charge:

Monthly adjustment x total kWh.

The average fuel cost recovery rate for calendar years 1990 and 1991 was $0.0140/kWh.

Minimum monthly bill:

$55 base charge
+ $8 per kW of billing demand (but not less than $3,400)
+ power factor charge and fuel cost recovery.

2.2.2 Natural Gas Rates

Natural gas is supplied to Fort McPherson under rate N-16, Large Commercial Interruptible Service, from Atlanta Gas Light Company. The current rates and contracted amounts have been in effect since 1992. The natural gas rate is broken down into four parts, as follows:

- Monthly customer charge
- Firm use charge
- Consumption (energy) charge
- Gas adjustment charge.

Monthly customer charge: $250.

Firm use charge: $7,800 (Based on minimum daily availability of 6,000 therms at $1.30.)

Consumption charge:

Monthly meter reading

(MCF) x 10.29 therms/MCF = therms

Cost of first 100,000 therms	$0.070 per therm
Cost of next 200,000 therms	$0.057 per therm
Cost of over 300,000 therms	$0.047 per therm.

Gas adjustment charge:

Monthly adjustment x total therms.

The average gas adjustment charge for calendar years 1990 and 1991 was $0.397/therm, which accounts for 67% of annual gas costs at Fort McPherson.

2.2.3 Water and Sewer Rates

The charges for water services from the Atlanta Water System include the following:

Water Charges

Cost of first 3 CCF (base charge)	$3.35 total
Cost of next 67 CCF	$1.70 per CCF
Cost of next 600 CCF	$1.04 per CCF
Cost of over 670 CCF	$0.72 per CCF.

Sewage Charges

Cost, charged at 89% of metered water consumption	$1.20 per CCF.

2.3 HISTORICAL CONSUMPTION OF UTILITIES

Historical utility usage data for Fort McPherson was evaluated so savings figures could be compared with actual consumption.

2.3.1 Historical Electrical Energy Consumption

Electrical energy consumption for FY90 and FY91 is tabulated in Table 2-1 on page 2-4. The average monthly electrical consumption varies from a minimum of 2,725,200 kWh in November,

to a maximum of 4,348,800 kWh in August. The monthly electrical consumption is illustrated graphically on Figure 2-1 on page 2-5.

Electrical energy consumption for Building 200 is 32% of the total electrical energy used at Fort McPherson. This electrical consumption is read and recorded by the Director of Engineering and Housing (DEH) personnel. The electrical energy consumption of Building 200 for FY90 and FY91 is also presented in Table 2-1 below, for information purposes. The monthly electrical consumption of Building 200 is also illustrated graphically on Figure 2-1 on page 2-5.

TABLE 2-1
ELECTRICAL ENERGY CONSUMPTION
FORT MC PHERSON

Month	Post-wide Electrical Consumpt. kWh, FY90	Post-wide Electrical Consumpt. kWh, FY91	Bldg. 200 Electrical Consumpt. kwh, FY90	Bldg. 200 Electrical Consumpt. kWh, FY91	Post-wide Electrical Consumpt. kWh Avg.90/91	Bldg. 200 Electrical Consumpt. kWh Avg.90/91
Oct.	2,966,400	3,290,400	1,163,200	1,298,400	3,128,400	1,230,800
Nov.	2,512,800	2,937,600	1,328,800	1,262,400	2,725,200	1,295,600
Dec.	3,081,600	2,865,600	1,206,400	1,217,600	2,973,600	1,212,000
Jan.	3,441,600	2,844,000	1,155,200	1,152,800	3,142,800	1,154,000
Feb.	2,577,600	2,844,000	1,207,200	1,295,200	2,710,800	1,251,200
March	2,937,600	2,671,200	1,044,000	1,100,000	2,804,400	1,072,000
April	2,620,800	3,110,400	1,046,400	1,315,200	2,865,600	1,180,800
May	3,088,800	3,038,400	1,128,000	1,113,600	3,063,600	1,120,800
June	3,686,400	3,513,600	1,188,800	1,274,400	3,600,000	1,231,600
July	3,801,600	4,226,400	1,163,200	1,449,600	4,014,000	1,306,400
Aug.	4,471,200	4,226,400	1,269,600	1,240,800	4,348,800	1,255,200
Sept.	3,672,000	3,607,200	1,590,400	993,600	3,639,600	1,292,000
TOTAL	38,858,400	39,175,200	14,491,200	14,713,600	39,016,800	14,602,400

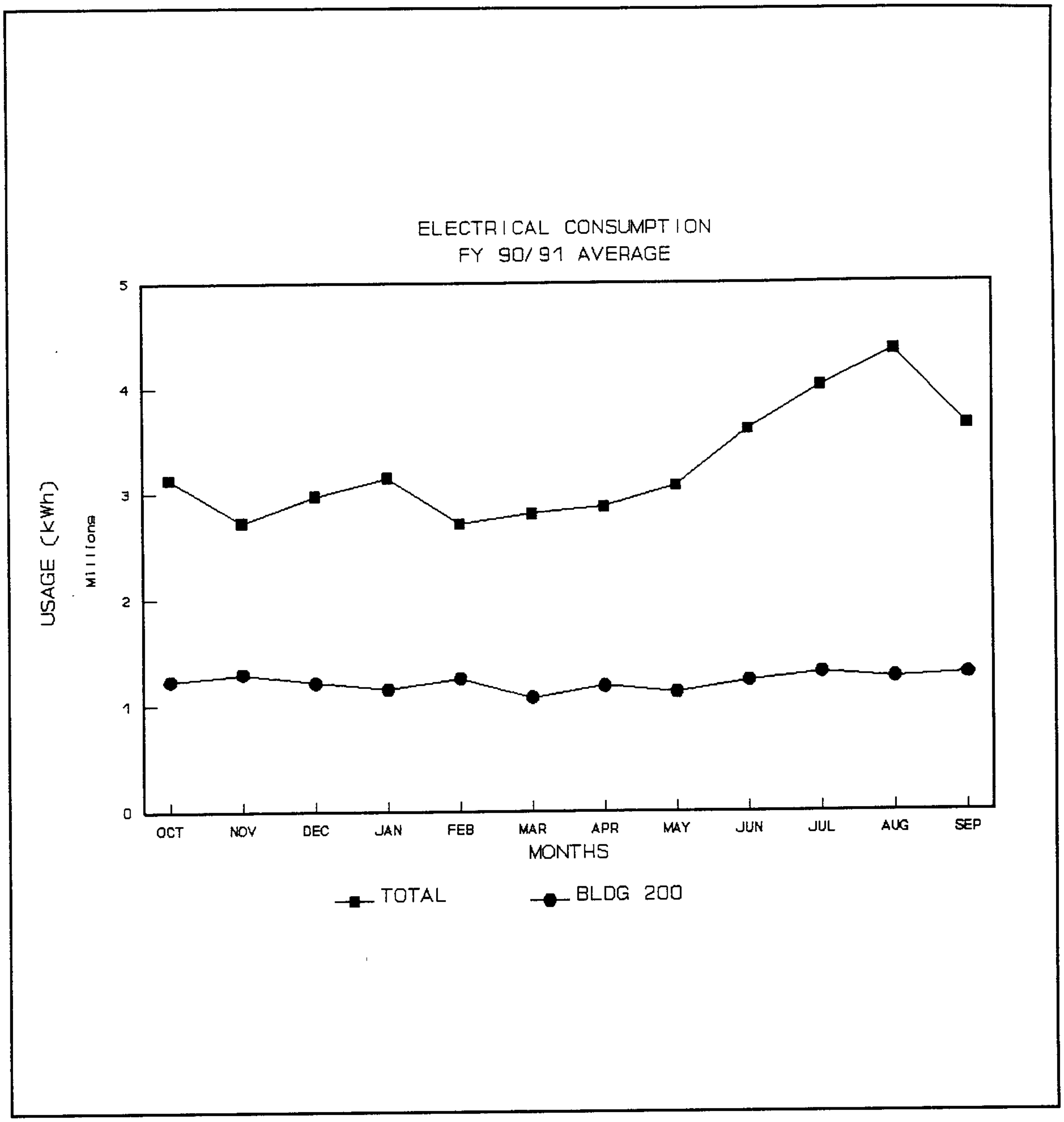


FIGURE 2-1
ELECTRICAL CONSUMPTION

2.3.2 Historical Natural Gas Consumption

Natural gas consumption for FY90 and FY91 is tabulated in Table 2-2 below. The average monthly natural gas consumption varies from a minimum of 13,718 therms in August, to a maximum of 155,068 therms in January. The monthly natural gas consumption is illustrated graphically in Figure 2-2 on page 2-7.

Building 200 is an all-electric building, so it consumes no gas.

TABLE 2-2
NATURAL GAS CONSUMPTION
FORT MC PHERSON

Month	Post-wide Natural Gas Consumption (Therms - FY90)	Post-wide Natural Gas Consumption (Therms - FY91)	Post-wide Natural Gas Consumption (Therms - Avg.)
Oct.	40,565	33,899	37,232
Nov.	69,750	71,820	70,785
Dec.	128,769	117,323	123,046
Jan.	147,128	163,007	155,068
Feb.	113,588	122,905	118,247
March	93,751	99,507	96,629
April	57,239	30,242	43,741
May	19,608	16,032	17,820
June	15,426	13,597	14,512
July	14,101	12,819	13,460
Aug.	13,957	13,479	13,718
Sept.	15,100	13,974	14,537
TOTAL	728,982	708,604	718,793

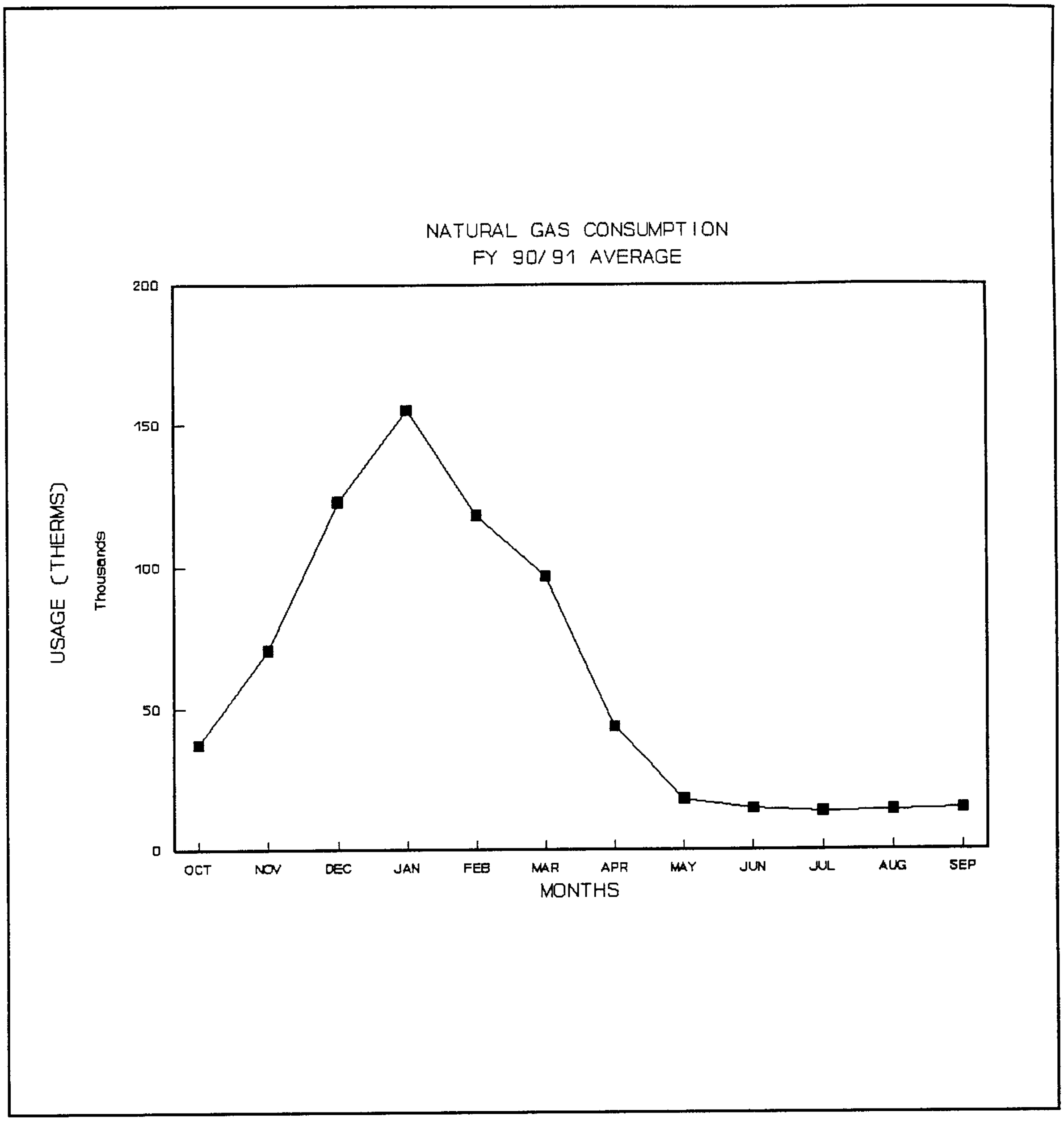


FIGURE 2-2
NATURAL GAS CONSUMPTION

2.4 SUMMARY OF UTILITIES

The percentage comparison of historical consumption and cost for electricity and natural gas is tabulated in Table 2-3 below.

TABLE 2-3
FY91 UTILITY USAGE AND COST COMPARISON

UTILITY	CONSUMPTION FY91		COST FY91	
	(MBtu)	(%)	($)	(%)
Electricity	133,705	65	1,897,111	82
Natural Gas	70,860	35	421,996	18
Total	204,565	100	2,319,107	100

2.5 BASIS FOR ECONOMIC ANALYSIS

2.5.1 ECIP Guidance

The ECIP funding program criteria were used to determine project economics. The latest version of "Life Cycle Cost in Design (LCCID)" program, developed by the U.S. Army Construction Engineering Research Laboratory, was used to calculate life cycle cost benefits. The maximum economic life and uniform present worth (UPW) factors for natural gas, electricity, and non-energy items for DOE Region 3, from NISTIR-85 are listed in Table 2-4 on page 2-9.

TABLE 2-4
UNIFORM PRESENT WORTH FACTORS

CATEGORY	MAXIMUM ECONOMIC LIFE	UPW ELEC-TRICITY	UPW NATURAL GAS	UPW NON-ENERGY
Steam and condensate systems (including insulation)	25	15.61	23.77	14.53
HVAC, including controls	15	11.11	14.45	10.59
Weatherization	25	15.61	23.77	14.53
Lighting systems	25	15.61	23.77	14.53
Energy recovery systems	25	15.61	23.77	14.53
Electrical energy systems, including motor replacements	25	15.61	23.77	14.53

2.5.2 Basis for Energy Cost Savings Benefits

Unit utility costs were calculated from contract information and historical data, to be used with the energy savings in order to estimate the dollar savings.

For electricity, the following unit cost was used:

- Average electrical energy charge = $0.0255 per kWh
- Annual peak electrical demand charge = $8.85 per kW.

For natural gas, the following unit cost was used:

- Average natural gas energy charge = $4.67 per MBtu.

For water and sewer, the following unit cost was used:

- Combined water and sewer charge = $2.39 per thousand gallons.

2.5.3 Basis for Labor and Material Costs

The following sources were used to develop the cost estimates of materials:

- Mean's Cost Data, 1992 Editions
- Actual cost from similar construction projects
- Equipment vendor estimates.

2.6 DEMAND SIDE MANAGEMENT

On January 10, 1992, Georgia Power Company submitted for approval to the state Public Service Commission of Georgia 14 energy efficiency, demand side management programs. The Public Service Commission of Georgia has 300 days to accept or reject the programs or to provide an alternative program.

The proposed programs will potentially provide Fort McPherson future incentives for demand side management conversions. Of interest to Fort McPherson are those programs in the categories of Commercial and Industrial Areas, Process Systems, and Buildings Systems.

Process Systems includes:

- Motors
- Custom energy services
- Small energy services
- Energy analysis
- Interruptible service.

Building Systems includes:

- Lighting
- HVAC
- New construction
- Standby generation.

If the demand side management program is approved by the Public Service Commission of Georgia, various ECOs evaluated in this ESOS could receive incentives. A preliminary statement issued by the Commission on 7 July 1992 did not include a decision on the demand side management programs.

SECTION 3.0

EVALUATION OF ENERGY CONSERVATION OPPORTUNITIES

3.1 GENERAL

A total of 19 ECO projects were evaluated in this study. The evaluation of each ECO was performed as if it were the only ECO implemented. Any reduction of total energy savings resulting from the simultaneous implementation of more than one ECO, if any, was not taken into consideration. A summary of the ECOs evaluated is provided in Section 3.5.

3.2 ECOs EVALUATED

The 17 ECO projects identified in the SOW to be evaluated for selected buildings are listed in Table 3-1 on page 3-2.

During the entrance interview conference, ECO 18 was added, which uses a replacement kit to convert exit signs from incandescent lamps to fluorescent lamps. ECO 18 was evaluated for all buildings specified for ECO 15, lighting controls.

After discussions with DEH, it was also agreed to include the results of previous lighting studies (see Section 1.6), which were originally evaluated as shared energy savings projects. The results are included as ECO 19; economics are based on design, bid, and construction, direct by the Government, rather than by an energy service contractor under a shared energy savings contract.

After the survey, each ECO for each building was reviewed to determine if it was technically feasible. ECOs which are not technically feasible were eliminated from further evaluation. A complete list of these ECOs, and the reasons they were eliminated are included in Table 3-2 beginning on page 3-3.

In addition, as the facilities were surveyed, some ECOs included in the SOW were found to apply to buildings not identified in the ECO matrix (Annexes B and C). With the approval of DEH, these buildings were added to the original list. Table 3-3 on page 3-5 lists buildings added to the ECO evaluations.

Table 3-4 beginning on page 3-6 is a building-ECO matrix, indicating which ECOs are:

- Applicable and evaluated projects
- Not applicable and dropped from further evaluation
- Added as an applicable project.

TABLE 3-1
ENERGY CONSERVATION OPPORTUNITIES LIST

ECO NUMBER	ECO DESCRIPTION
1	Insulate Walls, Roofs, Pipes, and Ducts
2	Insulate Windows
3	Weatherstripping and Caulking
4	Domestic Hot Water Temperature
5	Install High Efficiency Electric Motors
6	Economizers
7	Control Hot Water Circulation Pump
8	Install Low-Flow Shower and Faucet Fixtures
9	Heat Reclaim from Hot Refrigerant Gas
10	Prevent Air Stratification
11	Replace Street Lights
12	Revise or Repair HVAC Controls
13	Thermal Storage
14	Radiant Heaters and Loading Dock Seals
15	Separate Light Switches
16	Investigate Post Demand Usage
17	Boiler Operation Schedule
18	Replace Exit Sign Bulbs with Fluorescent Bulb Kit
19	Previous Lighting Review Study

TABLE 3-2
NONFEASIBLE ECOs

BLDG. NO.	ECO NO.	REASON ECO NONFEASIBLE
22	1	Has adequate insulation
	2	Has double pane windows
	8	Has low-flow fixtures
	12	Has adequate controls for HVAC
27	1	Has adequate insulation
	2	Has double pane windows
28	1	Has adequate insulation
	2	Has double pane windows
40	1	Has adequate insulation
41	1	Has adequate roof insulation
41	2	Has double pane windows
42	1	Has adequate wall, roof, and pipe insulation
61	1	Has adequate insulation
100	1	Has adequate insulation
	2	Has double pane windows
101	1	Has adequate insulation
102	1	Has adequate wall, roof, and pipe insulation
	3	Has adequate caulking and weatherstripping
105	1	Has adequate wall, roof, and pipe insulation
	2	Has double pane windows
109	1	Has adequate wall, roof, and duct insulation
117	4	No DHW in building
131	6	Building has openable windows, thus economizers are not required
155	1	Has adequate insulation
170	6	Building has openable windows, thus economizers are not required
171	6	Building has openable windows, thus economizers are not required

TABLE 3-2
NONFEASIBLE ECOs
(Concluded)

BLDG. NO.	ECO NO.	REASON ECO NONFEASIBLE
178	1	Has adequate insulation
	2	Has double pane windows
	3	Has adequate weatherstripping and caulking
179	1	Has adequate insulation
	2	Has double pane windows
	3	Has adequate weatherstripping and caulking
181	2	Has double pane windows
184	1	Has adequate insulation
187	13	Building too small for thermal storage
200	9	Has heat reclaim
206	7	Existing controls are new and in excellent condition
250	12	Has adequate controls for HVAC
358	1	Has adequate insulation
	2	Has double pane windows
360	14	Has air curtains and unit heaters; loading dock seals are not applicable
366	14	Minimal application for radiant heat; no application for loading dock seals
400	1	Has adequate wall, roof, and pipe insulation
	2	Has double pane windows
	3	Has adequate caulking and weatherstripping
522	1	Has adequate wall, roof, and duct insulation
	2	Has double pane windows
27, 28, 102, 105, 109, 111-126, 178, 179, 187, 250, 366	5	No motors over 1 horsepower
General	17	This ECO applied to buildings at Fort Gillem only

TABLE 3-3
BUILDINGS ADDED

ECO NO.	BLDG. NO.	COMMENTS
1	168	Evaluate roof insulation
1	360	Evaluate pipe insulation
6	181	Evaluate economizers
12	100, 131, 170, 171	Evaluate HVAC controls
12	200	Evaluate ventilation controls
13	60, 170, 171, 181, 184, 500	Evaluate thermal storage
15	200	Evaluate lighting controls
18	41, 56, 58, 60, 62, 101, 170, 171, 181, 184, 200, 246, 363, 366, 400, 401	Evaluate exit sign retrofits

TABLE 3-4
BUILDING-ECO MATRIX

BLDG #	DESCRIPTION	ECO NUMBER																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
022	Administration	N	N	A	A	A			N				N				A			A*
027	Guest	N	N	A	A	N			A								A			A*
028	Guest	N	N	A	A	N			A								A			A*
040	UPH	N	A	A	A	A			A								A			A*
041	Administration	A	N	A	A	A										A	A		A*	A*
042	Chapel	A	A	N	A	A											A			A*
056	UPH		A*	A*	A	A			A				A			A	A		A*	A*
058	UPH		A*	A*	A	A			A				A			A	A		A*	A*
060	UPH		A*	A*	A	A			A				A	A*		A	A		A*	A*
061	Mess Hall/Lab	N	A	A	A	A											A			A*
062	UPH				A	A			A				A			A	A		A*	A*
100	Dental	N	N	A	A	A							A*				A			A*
101	Dental	N	A	A	A	A							A			A	A		A*	A*
102	Police	A	A	N	A	N											A			A*
105	Lab	A	N	A	A	N											A			A*
109	Guest	A	A	A	A	N			A								A			A*
111	Administration	A	A	A	A	N											A			A*

A - Applicable and evaluated project
N - Not applicable and dropped from further analysis
A* - Added as an applicable project

TABLE 3-4
BUILDING-ECO MATRIX

BLDG #	DESCRIPTION	ECO NUMBER																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
112	Administration	A	A	A	A	N											A			A*
114	Administration	A	A	A	A	N											A			A*
116	Administration	A	A	A	A	N											A			A*
117	Classroom	A	A	A	N	N											A			A*
118	Administration	A	A	A	A	N											A			A*
120	Administration	A	A	A	A	N											A			A*
121	Administration	A	A	A	A	N											A			A*
122	Administration	A	A	A	A	N											A			A*
124	Administration	N	A	A	A	N											A			A*
126	Administration	A	A	A	A	N											A			A*
131	Administration				A	A	N						A*				A			A*
155	NCO Club	A	A	A	A	A											A			A*
168	Admin. (VOQ)	A*			A	A			A				A				A			A*
170	Hospital				A	A	N	A		A			A*	A*		A	A		A*	A*
171	Hospital				A	A	N	A		A			A*	A*		A	A		A*	A*
178	Training	N	N	N	A	N											A			A*
179	Classroom	N	N	N	A	N											A			A*

A - Applicable and evaluated project
N - Not applicable and dropped from further analysis
A* - Added as an applicable project

TABLE 3-4
BUILDING-ECO MATRIX

BLDG #	DESCRIPTION	ECO NUMBER																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
181	Administration	A	N	N	A	A	A*			A			A	A*		A	A		A*	A*
184	Storage	N	A	N	A	A	A	A					A	A*		A	A		A*	A*
187	PX Maintenance				A	N								N			A			A*
200	Administration				A	A				N			A*	A		A*	A		A*	A*
206	Administration				A	A		N									A			A*
246	Administration				A	A	A						A	A		A	A		A*	A*
250	Library				A	N							N				A			A*
358	Administration	N	N	A	A	A	N						A				A			A*
360	Commissary	A*			A	A				A					N		A			A*
363	Maintenance				A	A			A*							A	A		A*	A*
366	Storage				A	N					A				N	A	A		A*	A*
400	Moral Support	N	N	N	A	A										A	A		A*	A*
401	Bowling				A	A			A*							A	A		A*	A*
500	Dining Facility				A	A	N	A		A			A	A*			A			A*
514	Day Care				A	A	A						A*				A			A*
522	Guest	N	N	A	A	A				A							A			A*

A - Applicable and evaluated project
N - Not applicable and dropped from further analysis
A* - Added as an applicable project

3.3 ANALYSIS METHODOLOGY

The methodology used for the energy savings and economic analyses includes:

- Prepare computer simulation of selected buildings.
- Run a modified computer simulation of selected buildings, with the ECO implemented, to determine the delta energy usage.
- Develop energy savings factors to extrapolate savings for typical buildings to similar buildings.
- Apply extrapolated energy savings factors to similar buildings.
- Estimate utility savings for various ECOs using manual calculations.
- Prepare cost estimate for ECOs.
- Calculate the total savings and costs for each ECO, including non-energy savings or costs.
- Perform an LCCID calculation to determine the project simple payback and SIR.
- Recommend ECO projects which have an overall project SIR greater than 1.0.
- See Appendix C of this Volume I for backup data on all ECOs.
- See Appendix E of Volume II for computer simulations of selected buildings.
- See Appendix F of Volume II for field survey data describing current conditions.

Special items considered in the analysis include:

- Using Atlanta weather data, the TRACE building simulation program was used to develop utility consumption estimates for 12 selected buildings. Table 3-5 on page 3-11 is a list of the selected buildings simulated and similar buildings for which estimates were extrapolated.
- Where applicable, the following ECOs were simulated on the selected buildings; the energy savings were then extrapolated to similar buildings:

  - ECO 1, Insulation (Wall and Roof)
  - ECO 2, Insulated Windows
  - ECO 3, Weatherstripping and Caulking
  - ECO 6, Economizers
  - ECO 7, Control Hot Water Circulation Pumps

- ECO 10, Prevent Air Stratification
- ECO 12, Revise or Repair HVAC Controls
- ECO 13, Thermal Storage
- ECO 15, Separate Light Switches
- ECO 17, Boiler Operation Schedule

- The utility savings for the following ECOs were determined using manual calculations:

  - ECO 1, Insulation (Pipe and Duct)
  - ECO 4, Domestic Hot Water Temperatures
  - ECO 5, High Efficiency Electric Motors
  - ECO 8, Low-Flow Shower and Faucet Fixtures
  - ECO 9, Heat Reclaim from Hot Refrigerant Gas
  - ECO 11, Replace Street Lights
  - ECO 14, Radiant Heaters and Loading Dock Seals
  - ECO 16, Investigate Post Demand Usage

- See Section 2.0 for utility rates and economic analysis descriptions.

3.4 ECO ANALYSIS

The following ECO sections detail the premises, field survey requirements, basis for analysis, energy savings calculations, improvement descriptions, results, and recommendations for each of the 19 ECOs to be evaluated in this study. Section 4.0 provides an economic summary of the ECOs evaluated. The construction cost identified in the ECO evaluations includes design cost (6%) and SIOH (5.5%). These additional costs were included after the Interim Submittal.

TABLE 3-5
COMPUTER SIMULATION BUILDINGS

BLDG. NUMBER	BLDG. FUNCTION	BLDG. CONSTRUCTION	BLDG. OCCUPANCY	SIMILAR BLDG. NUMBERS
027	Guest Housing	Frame	Continuous Sun. - Sat.	22, 28, 29
060	Housing	Brick - Block	0700 to 1700 Mon. - Fri.	40, 56, 58, 62
100	Administration	Brick - Frame	Continuous Sun. - Sat.	41, 42, 61, 101, 102, 105, 111, 112, 114, 116, 117, 118, 120, 121, 122, 124, 126
168	Housing and Administration	Brick - Frame	Continuous Sun. - Sat.	522
171	Clinic	Brick - Frame	0700 to 1700 Mon. - Fri.	170
181	Administration	Brick - Frame	0700 to 1700 Mon. - Fri.	
184	Administration	Brick - Frame	0700 to 1700 Mon. - Fri.	
200	Administration	Concrete - Frame	Continuous Sun. - Sat. 0800 to 1700 Mon. - Fri. Major Occupancy	
246	Administration	Block - Frame	0700 to 1600 Mon. - Fri.	
358	Administration	Frame	0700 to 1600 Mon. - Fri.	735
500	Officers Club	Frame	0700 to 2100 Mon. - Fri. 1600 to 2200 Sat. 1600 to 2000 Sun.	155
514	Day Care	Block	0600 to 1800 Mon. - Fri.	

3.4.1 ECO 1 - INSULATION

3.4.1.1 - Insulate Walls and Roofs

Premise:
This ECO involves adding insulation to existing walls and roofs which are inadequately insulated.

Field Survey:
The walls and roofs were surveyed to determine whether they contain adequate insulation. It was difficult to determine what insulation was present in the buildings with framed-in walls. Discussions with DEH revealed, however, recently remodeled buldings can be assumed to have have R-11 fiberglass batt insulation in the walls and R-19 insulation in the ceiling space. This assumption was verified, when possible, by examination of construction plans and of the buildings themselves.

Basis for Analysis:
Heat transfer through the walls and roof of a building is related to the resistance of the construction materials to heat flow. By increasing the resistance of the materials, heat transfer is reduced and energy saved. The most effective way to reduce heat transfer is to add insulation, thereby lowering the U-value. As the U-value decreases, the energy consumption will also decrease, thereby increasing the energy savings. The existing building wall and roof insulation can be improved, as follows:

Wall Insulation:

Bldg. 41:

1" isocyanurate and gypsum board can be installed on the interior of the frame wall for an increased R-value of 9.

Bldgs. 111, 112, 114, 116, 117, 118, 120, 121, 122, 126, 181:

2" polystyrene and stucco can be installed on the exterior of the brick wall for an added R-value of 10.

Roof Insulation:

Bldgs. 111, 112, 114, 116, 117, 118, 120, 121, 122, 126, 168, 181:

R-19 fiberglass batt insulation can be installed in the ceiling space.

Energy Savings Calculations:
First, the buildings were grouped by common building type. A typical building from each group was simulated by computer to create a baseline model. A second model was created to simulate the typical building, using a UA (U-value x Area) factor improved by additional insulation. These two models were compared as to the difference in UA factor and the corresponding difference in building energy consumption. The ratio of energy savings per unit UA differential was calculated and applied to the rest of the buildings in the group to determine the annual energy savings for each building.

3.4.1.1 Insulate Walls and Roofs (Continued)

Energy Savings Calculations: (Continued)
The following equations were used:

Existing UA	= (existing U-value) x (surface area)
Improved UA	= (improved U-value) x (surface area)
Differential UA	= existing UA - improved UA
Annual electric savings	= (UA differential) x (electric savings factor)
Annual demand savings	= (UA differential) x (demand savings factor)
Annual gas savings	= (UA differential) x (gas savings factor)

where:

Existing U-value	= Existing U-value of wall materials
Improved U-value	= Improved U-value (with insulation added)
Surface area	= Net wall or roof surface area from plans
Electric savings/UA ratio	= Calculated electric savings per change in UA for typical building
Demand savings factor	= Calculated demand savings per change in UA for typical building
Gas savings/UA ratio	= Calculated gas savings per change in UA for typical building

Tables 3-6 and 3-7 on pages 3-15 and 3-16 contain the results of analysis of this ECO.

3.4.1.1 Insulate Walls and Roofs (Continued)

Results: Walls
There were no buildings with an SIR greater than 1.0.

Recommendation: Do not implement.

Results: Roofs (Combined results for buildings with an SIR greater than 1.0.)

Annual Natural Gas Savings (MBtu)	51
Annual Electrical Energy Savings (kWh)	3,164
Annual Demand Savings (kW)	4
Annual Non-Energy Cost Savings	$0
Total Annual Cost Savings	$724
Estimated Construction Cost	$3,791
Analysis Period (years)	25
Simple Payback (years)	5.2
Savings-to-Investment Ratio (SIR)	3.4

Recommendation: Implement.

TABLE 3-6
ECO 1, WALL INSULATION

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
181	3	5,392	108	126	642	308	0	953	59,393	0.3	63
111	0	1,385	10	15	82	0	0	82	9,776	0.2	120
112	0	1,385	10	15	82	0	0	82	9,776	0.2	120
114	0	1,385	10	15	82	0	0	82	9,776	0.2	120
116	0	1,385	10	15	82	0	0	82	9,776	0.2	120
117	0	1,385	10	15	82	0	0	82	9,776	0.2	120
118	0	1,385	10	15	82	0	0	82	9,776	0.2	120
120	0	1,385	10	15	82	0	0	82	9,776	0.2	120
121	0	1,385	10	15	82	0	0	82	9,776	0.2	120
122	0	1,385	10	15	82	0	0	82	9,776	0.2	120
126	0	1,385	10	15	82	0	0	82	9,776	0.2	120
041	0	2,651	19	28	156	0	0	156	18,858	0.2	121

TABLE 3-7
ECO 1, ROOF INSULATION

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
168	4	3,164	51	62	318	406	0	724	3,791	3.4	5.2
111	0	619	3	5	29	0	0	29	1,630	0.3	56.0
112	0	619	3	5	29	0	0	29	1,630	0.3	56.0
114	0	619	3	5	29	0	0	29	1,630	0.3	56.0
116	0	619	3	5	29	0	0	29	1,630	0.3	56.0
117	0	619	3	5	29	0	0	29	1,630	0.3	56.0
118	0	619	3	5	29	0	0	29	1,630	0.3	56.0
120	0	619	3	5	29	0	0	29	1,630	0.3	56.0
121	0	619	3	5	29	0	0	29	1,630	0.3	56.0
122	0	619	3	5	29	0	0	29	1,630	0.3	56.0
126	0	619	3	5	29	0	0	29	1,630	0.3	56.0

3.4.1 ECO 1 - INSULATION

3.4.1.2 - Insulate Pipes and Ducts

Premise:
This ECO involves reducing energy consumption by adequately insulating ducts and pipes.

Field Survey:
Ducts and pipes in the unconditioned spaces (e.g., attics, crawl spaces, and mechanical rooms) of various buildings were surveyed. Ducts and pipes in conditioned spaces were not surveyed because heat transfer between the fluid and the space contributes to the conditioning of a space and is not considered a loss. The lengths and sizes of the ducts and pipes were determined from building drawings and field measurements. Type of fluid, type of insulation, and thickness of insulation were considered. In most cases, pipes and ducts were insulated.

Basis for Analysis:
Uninsulated or poorly insulated ducts and pipes in unconditioned spaces waste energy; adding adequate insulation will reduce losses. For the purpose of this analysis, adequate insulation thickness is defined as the recommended thickness from Corps of Engineers guide specifications and ASHRAE Standard 90.1 - 1989. Table 3-8 on page 3-20 lists the recommended thicknesses for pipes and ducts used in this ECO. These recommended thicknesses were compared with the survey data of existing insulation. Where it was determined pipes and ducts had no insulation or did not meet recommended insulation thickness, an analysis was done to determine the savings and costs involved with adding enough insulation to achieve the recommended thickness.

Energy Savings Calculations:
The energy savings for this ECO were calculated by subtracting the heat loss of ducts and pipes with recommended insulation thickness from the heat loss of pipes and ducts with existing insulation. The energy savings from a reduction in air leakage for ducts with no insulation was also taken into account. The following equations were used:

<u>Pipes</u>

Heat loss, Btu/h $= \dfrac{L(tf - ta)}{Rt}$

Rt, Total thermal resistance, $\dfrac{°F\ ft}{Btu}$ $= Rc + Rd$

Rc, Convection resistance, $\dfrac{°F\ ft}{Btu}$ $= \dfrac{1}{(.18(ts - ta)^{.33}(Pi(d+2w))}$

3.4.1.2 Insulate Pipes and Ducts (Continued)
Energy Savings Calculations: (Continued)

Rd, Conduction resistance, $\frac{°F\ ft}{Btu}$ $= \frac{\ln(ro/ri)}{2kPi}$

ts, surface temperature, °F $= ta + \frac{Rc}{Rc + Rd}(tf - ta)$

where:

tf = Fluid temperature, °F

ta = Ambient temperature, °F

w, inches = Insulation thickness

k, $\frac{Btu}{hr\ ft\ °F}$ = Thermal conductivity of insulation

L, feet = Pipe length

d, inches = Pipe diameter

Pi = 3.14

ro, inches = outside radius of pipe and insulation

ri, inches = inside radius of insulation

<u>Ducts</u>

Heat loss (insulation), Btuh = UA(tf - ta)

U, $\frac{Btu}{h\ °F\ ft^2}$ $= \frac{1}{RI + Rc + Rd}$

Rd, average conduction resistance, $\frac{°F\ h}{Btu}$ = 0.65

Rc, average convection resistance, $\frac{°F\ h}{Btu}$ $= \frac{1}{4.87(A)}$

RI, thermal resistance of insulation, $\frac{°F\ h}{Btu}$ $= \frac{1}{(k/w)}$

Heat loss (leakage-winter), Btuh = 1.1 cfm (tf - ta)

Heat loss (leakage-summer), Btuh = 4.5 cfm (delta enthalpy)

cfm $= \frac{FA}{100}$

F, leakage ratio cfm/100 ft² $= C_L P^{0.65}$

3.4.1.2 Insulate Pipes and Ducts (Continued)

where:

tf, °F	= Fluid temperature
ta, °F	= Ambient temperature
A, square feet	= Duct surface area
k, $\frac{Btu}{hr\ ft\ °F}$	= thermal conductivity of insulation
w, inches	= Insulation thickness
C_L, cfm/100 ft^2 @ 1 inch wg	= leakage class
P, inches wg	= static pressure

Tables 3-9 and 3-10 on pages 3-21 and 3-22 provide economic summaries for this ECO.

Results: Pipes (Combined results for buildings with SIR greater than 1.0)

Annual Natural Gas Savings (MBtu)	880
Annual Electrical Energy Savings (kWh)	24
Annual Demand Savings (kW)	0
Annual Non-Energy Cost Savings	$0
Total Annual Cost Savings	$4,110
Estimated Construction Cost	$10,717
Analysis Period (years)	25
Simple Payback (years)	2.6
Savings-to-Investment Ratio (SIR)	9.1

Recommendation: Implement.

Results: Ducts (Combined results for buildings with SIR greater than 1.0)

Annual Natural Gas Savings (MBtu)	243
Annual Electrical Energy Savings (kWh)	29,656
Annual Demand Savings (kW)	0
Annual Non-Energy Cost Savings	$0
Total Annual Cost Savings	$1,893
Estimated Construction Cost	$9,625
Analysis Period (years)	25
Simple Payback (years)	5.1
Savings-to-Investment Ratio (SIR)	4.0

Recommendation: Implement.

TABLE 3-8
ECO 1.2, DUCT AND PIPE RECOMMENDED THICKNESSES

FLUID	PIPE SIZE (inches)				
	0.25 - 1.00	1.25 - 2.00	2.25 - 3.00	3.25 - 4.00	4.25 - 6.0
CHILLED WATER PIPES					
Fiberglass	0.50	0.75	1.00	1.00	1.00
Rubber	1.00	1.00	1.00	1.00	1.00
Foam	1.50	1.50	1.50	2.00	2.00
HOT WATER PIPES (Also Condensate)					
Fiberglass	1.50	1.50	1.50	1.50	1.50
Rubber	1.50	1.50	1.50	2.50	2.50
Foam	1.50	1.50	1.50	2.50	2.50
STEAM PIPES					
Fiberglass	2.00	2.50	2.50	3.00	3.50
Rubber	1.50	1.50	1.50	2.50	2.50
Foam	1.50	1.50	1.50	2.50	2.50
DUCTS	All Sizes				
	2" Fiberglass				

TABLE 3-9
ECO 1, PIPE INSULATION

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
155	0	0	654	654	3,052	0	0	3,052	3,364	21.6	1.1
360	0	0	41	41	193	0	0	193	303	15.1	1.6
111	0	4	12	12	58	0	0	58	155	8.8	2.7
061	0	0	105	105	491	0	0	491	3,564	3.3	7.3
117	0	20	8	8	38	0	0	38	283	3.1	7.5
112	0	0	60	60	278	0	0	278	3,047	2.2	10.9
Total	0	24	880	880	4,110	0	0	4,110	10,717	9.1	2.6
041	0	0	3	3	14	0	0	14	644	0.5	45.2
109	0	0	1	1	4	0	0	4	328	0.3	87.7
522	0	0	1	1	7	0	0	7	849	0.2	123.6
042	0	0	0	0	2	0	0	2	226	0.2	127.5

TABLE 3-10
ECO 1, DUCT INSULATION

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
105	0	469	4	5	29	0	0	29	104	5.7	3.6
116	0	10,385	86	121	665	0	0	665	2,701	5.1	4.1
358	0	9,412	77	110	602	0	0	602	2,426	5.1	4.0
042	0	7,408	61	87	475	0	0	475	1,945	5.0	4.1
118	0	1,982	15	22	122	0	0	122	2,449	1.0	20.1
Total	0	29,656	243	345	1,893	0	0	1,893	9,625	4.0	5.1
102	0	1,092	8	11	63	0	0	63	1,825	0.7	28.9
041	0	619	4	6	35	0	0	35	1,088	0.7	30.8
114	0	1,216	7	11	64	0	0	64	2,857	0.4	44.8
400	0	1,954	11	18	102	0	0	102	4,591	0.4	44.8
022	0	556	3	5	29	0	0	29	1,306	0.4	44.8
155	0	884	4	7	41	0	0	41	2,721	0.3	52.1

3.4.2 ECO 2 - INSULATED WINDOWS

Premise:
This ECO involves replacing existing single pane windows with insulated glass (double pane) windows.

Field Survey:
Selected buildings were surveyed to examine the windows and determine whether they were single or double pane windows. Buildings which already have double pane windows were eliminated from the analysis. Many of the historical buildings have single pane windows.

Basis for Analysis:
Heat transfer through a window is a function of its resistance to heat flow (U-value) and solar radiation gains (shading coefficient). Replacing single panes with double panes lowers both the U-value and shading coefficient of a window, resulting in decreased heat flow and solar radiation gains. Energy savings are thus achieved. In historical buildings, replacement windows would have the same appearance as the existing windows.

Energy Savings Calculations:
The buildings were grouped by common building type. A typical building from each group was simulated by computer to create a baseline model. A second model was then created to simulate double pane windows. The difference in energy consumption between the two models is the energy savings. The energy savings per square foot of window area was calculated and extrapolated to the rest of the buildings in the group, to calculate the annual energy savings for each building. The following equations were used:

Electric savings	=	(window area) x (electric savings per sqft)
Demand savings	=	(window area) x (demand savings per sqft)
Gas savings	=	(window area) x (gas savings per sqft)

Table 3-11 beginning on page 3-24 contains the results of analysis of this ECO.

Results: There were no buildings with an SIR greater than 1.0.

Recommendation: Do not implement.

TABLE 3-11
ECO 2, INSULATED WINDOWS

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
040	1	920	60	63	302	123	0	425	40,927	0.2	96
056	2	1,276	83	87	419	170	0	589	69,343	0.2	118
058	2	1,276	83	87	419	170	0	589	69,343	0.2	118
060	2	1,549	101	106	509	206	0	715	87,834	0.2	123
155	1	28	6	6	27	60	0	87	7,107	0.2	82
184	4	1,925	41	48	241	411	0	651	67,390	0.2	103
109	1	408	7	8	43	57	0	99	14,294	0.1	144
042	0	41	1	1	5	0	0	5	9,193	0.0	2,009
061	0	77	1	2	9	0	0	9	17,314	0.0	2,018
101	0	130	2	3	15	0	0	15	30,891	0.0	2,125
102	0	23	0	1	3	0	0	3	5,872	0.0	2,259
111	0	49	1	1	6	0	0	6	14,294	0.0	2,591
112	0	49	1	1	6	0	0	6	11,830	0.0	2,145
114	0	49	1	1	6	0	0	6	11,830	0.0	2,145
116	0	49	1	1	6	0	0	6	11,830	0.0	2,145
117	0	49	1	1	6	0	0	6	11,830	0.0	2,145

TABLE 3-11 (Continued)
ECO 2, INSULATED WINDOWS

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
118	0	49	1	1	6	0	0	6	11,830	0	2,145
120	0	49	1	1	6	0	0	6	11,830	0	2,145
121	0	49	1	1	6	0	0	6	11,830	0	2,145
122	0	49	1	1	6	0	0	6	11,830	0	2,145
124	0	49	1	1	6	0	0	6	11,830	0	2,145
126	0	49	1	1	6	0	0	6	11,830	0	2,145

3.4.3 ECO 3 - WEATHERSTRIPPING AND CAULKING

Premise:
This ECO involves providing weatherstripping and caulking around windows and doors to reduce infiltration.

Field Survey:
Selected buildings were surveyed to examine the weatherstripping and caulking around doors and windows. The condition of the weatherstripping and caulking varied greatly in the buildings; overall, weatherstripping and caulking were in fair condition.

Basis for Analysis:
Outside air infiltration into a building through cracks, openings, and gaps around doors and windows increases building heating and cooling loads. Adequate weatherstripping and caulking around the windows and doors decreases the amount of infiltration into the building, which saves energy.

Energy Savings Calculations:
The buildings were grouped by common building type. A typical building from each group was simulated by computer to create a baseline model. A second model was then created to simulate reduced infiltration achieved by the addition of weatherstripping and caulking. The difference in energy consumption between the two models is the energy savings. The energy savings per cfm of infiltration was calculated and extrapolated to the rest of the buildings in the group to calculate the annual energy savings for each building. The following equations were used:

Infiltration Air Flow	$= L(A(dT) - B(v^2))^{1/2}$
Delta Infiltration flow	= Existing infiltration air flow - improved infiltration air
Annual Electric Savings	= (Infiltration savings) x (electric savings per cfm of infiltration)
Annual Demand Savings	= (Infiltration savings) x (demand savings per cfm of infiltration)
Annual Gas Savings	= (Infiltration savings) x (gas savings per cfm of infiltration)

Where:

L	= effective leaking area = (leakage area) x (leakage factor)
Infiltration air flow, cfm	= Calculated infiltration for doors and windows

3.4.3 ECO 3 - WEATHERSTRIPPING AND CAULKING (Continued)

Energy Savings Calculations: (Continued)

A, $cfm^2\ in^{-4}\ f^{-1}$	= ASHRAE stack coefficient for building
dT, °F	= Avg. temperature difference between inside and outside
B, $cfm^2\ in^{-4}\ f^{-2}$	= ASHRAE wind coefficient for building
v, mph	= Avg. local wind speed
Leakage area, ft^2	= Area of doors and windows
Leakage factor, in^2/ft^2	= ASHRAE coefficient to account for weatherstripping and caulking
Electric savings per cfm of infiltration savings	= Calculated electric savings per change in infiltration for typical building
Demand savings per cfm of infiltration savings	= Calculated demand savings per change in infiltration for typical building
Gas savings per cfm of infiltration savings	= Calculated gas savings per change in infiltration for typical building

Table 3-12 on page 3-28 contains the results of analysis of this ECO.

Results: (Combined results for buildings with SIR greater than 1.0)

Annual Natural Gas Savings (MBtu)	1
Annual Electrical Energy Savings (kWh)	22
Annual Demand Savings (kW)	2
Annual Non-Energy Cost Savings	0
Total Annual Cost Savings	$240
Estimated Construction Cost	$1,485
Analysis Period (years)	25
Simple Payback (years)	6.2
Savings-to-Investment Ratio (SIR)	2.4

Recommendation: Implement.

TABLE 3-12
ECO 3, WEATHERSTRIPPING AND CAULKING

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
155	2	22	1	1	5	234	0	240	1,485	2.4	6.2
056	1	413	16	17	84	91	0	174	10,779	0.3	62
058	1	413	16	17	84	91	0	174	14,053	0.2	81
060	1	470	18	19	95	103	0	199	3,942	0.9	20
061	0	326	2	3	17	0	0	17	2,424	0.1	146
101	0	565	3	5	29	0	0	29	4,914	0.1	171
105	0	112	1	1	6	0	0	6	1,226	0.1	216
109	0	199	1	2	10	0	0	10	2,779	0.1	274
111	0	187	1	2	10	0	0	10	2,378	0.1	250
112	0	153	1	1	8	0	0	8	1,907	0.1	245
114	0	180	1	2	9	0	0	9	2,227	0.1	243
116	0	132	1	1	7	0	0	7	1,737	0.1	258
117	0	187	1	2	10	0	0	10	2,378	0.1	250
118	0	187	1	2	10	0	0	10	2,378	0.1	250
120	0	187	1	2	10	0	0	10	2,378	0.1	250
121	0	187	1	1	5	0	0	5	1,417	0.1	265

TABLE 3-12 (Continued)
ECO 3, WEATHERSTRIPPING AND CAULKING

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
122	0	187	1	2	10	0	0	10	2,378	0.1	250
124	0	165	1	1	8	0	0	8	2,334	0.1	277
126	0	165	1	1	8	0	0	8	2,334	0.1	277
022	0	0	0	0	2	0	0	2	5,551	0.0	3,609
027	0	0	1	1	3	0	0	3	5,839	0.0	2,185
028	0	0	1	1	3	0	0	3	5,839	0.0	2,185
040	0	22	1	1	4	0	0	9	6,740	0.0	722
041	0	139	1	1	7	0	0	7	4,369	0.0	618
100	0	23	0	0	1	0	0	1	2,424	0.0	2,071
522	0	4	0	0	1	0	0	1	3,655	0.0	2,957
358	0	(4)	(0)	(0)	(0)	0	0	(0)	--	--	--

3.4.4 ECO 4 - DOMESTIC HOT WATER TEMPERATURE

Premise:
The purpose of this ECO is to measure the temperature of the domestic hot water (DHW) in selected buildings. No modifications to the DHW system are included in the SOW.

Field Survey:
The DHW temperatures were measured at various faucets in the building. These temperatures range from a low of 84°F in Building 250 to a high of 180°F in Building 155. Table 3-13 beginning on page 3-31 lists the DHW temperatures measured during the surveys.

Recommendation: To minimize energy consumption, set the water heater thermostat at the lowest temperature at which hot water will meet the occupants' needs.

TABLE 3-13
ECO 4, DOMESTIC HOT WATER TEMPERATURE MEASUREMENTS

Bldg. No.	Bldg. Description	DHW Temp. °F	Bldg. No.	Bldg. Description	DHW Temp. °F	Bldg. No.	Bldg. Description	DHW Temp. °F
22	Admin.	130	60	Housing	150	112	Admin.	134
22	Admin.	134	60	Housing	145	112	Admin.	136
27	Guest	130	60	Housing	120	114	Admin.	101
27	Guest	129	60	Housing	101	116	Admin.	113
27	Guest	128	61	Lab	144	117	Admin.	N/A
27	Guest	127	61	Lab	144	118	Admin.	N/A
28	Guest	148	62	Housing	127	120	Admin.	N/A
28	Guest	149	100	Dental	100	121	Admin.	N/A
40	Housing	131	101	Dental	124	122	Admin.	113
40	housing	129	101	Dental	128	124	Admin.	121
41	Admin.	154	102	Police	119	126	Admin.	121
41	Adm....	148	105	Lab	137	131	Clinic	124
42	Chapel	140	105	Lab	137	131	Clinic	124
42	Chapel	142	109	Guest	131	155	Club	180
56	Housing	136	109	Guest	129	155	Club	170
58	Housing	136	111	Admin.	114	168	Admin.	127
			111	Admin.	114	168	Admin.	125

TABLE 3-13 (Continued)
ECO 4, DOMESTIC HOT WATER TEMPERATURE MEASUREMENTS

Bldg. No.	Bldg. Description	DHW Temp. °F	Bldg. No.	Bldg. Description	DHW Temp. °F	Bldg. No.	Bldg. Description	DHW Temp. °F
170	Hospital	121	250	Library	84	500	Dining	146
171	Hospital	104	358	Admin.	134	500	Dining	134
178	Training	126	358	Admin.	139	514	Day Care	97
179	Classroom	149	360	Lab	126	514	Day Care	150
181	Admin.	168	360	Lab	124	522	Guest	125
184	Storage	122	363	Maint.	101			
184	Storage	134	363	Maint.	122			
187	PX	133	363	Maint.	125			
200	Admin.	110	363	Maint.	128			
200	Admin.	135	363	Maint.	111			
200	Admin.	140	363	Maint.	134			
200	Admin.	113	366	Storage	108			
200	Admin.	102	400	Moral	109			
200	Admin.	104	400	Moral	109			
200	Admin.	108	401	Bowling	121			
206	Admin.	132	401	Bowling	137			
246	Admin.	135						

3.4.5 ECO 5 - INSTALL HIGH EFFICIENCY ELECTRIC MOTORS

Premise:
This ECO involves replacing existing standard efficiency motors with new high-efficiency motors to save electrical energy in selected buildings.

Field Survey:
Nameplate data was collected on existing motors and the power consumption of motors above 10 hp was measured (see Appendix E). Motors having measured FLA 25% less or 10% more than the nameplate FLA were noted. This condition could indicate the motors are undersized or oversized, respectively, for the application. Most motors were NEMA Design B, with standard efficiency ratings.

Basis for Analysis:
Motor efficiency is the ratio of the energy output of the motor to energy input. The lower the efficiency, the more energy will be expended for a given output. By replacing standard efficiency motors with premium efficiency motors, electrical energy will be saved.

Energy Savings Calculations:
Energy savings was calculated by subtracting the electrical demand of a premium efficiency motor from that of the existing motor and multiplying that difference by the annual hours of operation. The following equations were used:

Electrical demand (kW) = (hp x 0.746 x LF) x (1/motor eff.)

Electrical energy savings (kWh/yr) = ((kW of existing motor) - (kW of high efficiency motor)) x (hrs of operation per yr)

where:

hp	= Motor nameplate horsepower
0.746	= kW per horsepower
LF	= Motor load factor
Motor eff.	= Efficiency of motor

Nameplate information was used for existing motors. If nameplate information was not available on existing motors, data for a NEMA Design B, 1750 rpm, standard motor was used. The savings available due to premium efficiency motors was corrected for motor load. For motors controlled by variable frequency drives, the motor load was reduced to account for annual load factor reduction due to variable volume HVAC equipment. The efficiency of the variable frequency drive would remain the same for either type of motor, and does not change the predicted savings.

3.4.5 ECO 5 - INSTALL HIGH EFFICIENCY ELECTRIC MOTORS (Continued)

Table 3-14 beginning on page 3-35 contains the results of analysis of this ECO.

Results: (Combined results for buildings with SIR greater than 1.0)

Annual Natural Gas Savings (MBtu)	0
Annual Electrical Energy Savings (kWh)	264,518
Annual Demand Savings (kW)	54
Annual Non-Energy Cost Savings	$0
Total Annual Cost Savings	$12,339
Estimated Construction Cost	$162,986
Analysis Period (years)	25
Simple Payback (years)	13.2
Savings-to-Investment Ratio (SIR)	1.1

Recommendation: Implement.

If electric motors are being replaced due to failure, the DEH should consider replacing standard efficiency motors with premium efficiency motors. The differential cost of a premium efficiency motor versus a standard efficiency motor will pay back over a short period due to the utility savings. A table of system economics for various motor sizes and operating hours is provided in Appendix C with ECO 5 backup calculations.

TABLE 3-14
ECO 5, INSTALL HIGH EFFICIENCY ELECTRIC ELECTRIC MOTORS

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
514	0	3,004	0	10	77	35	0	112	782	2.2	7.0
206	1	8,329	0	28	212	98	0	310	2,207	2.1	7.1
360	0	3,294	0	11	84	39	0	123	1,103	1.7	9.0
200	37	167,856	0	572	4,280	3,839	0	8,119	107,960	1.1	13.3
056	1	8,276	0	28	211	97	0	308	4,126	1.1	13.4
058	1	8,276	0	28	211	97	0	308	4,126	1.1	13.4
060	1	8,276	0	28	211	97	0	308	4,126	1.1	13.4
062	1	8,276	0	28	211	97	0	308	4,126	1.1	13.4
246	1	4,700	0	16	120	64	0	183	2,544	1.1	13.9
363	7	23,735	0	81	605	763	0	1,368	18,911	1.1	13.8
181	0	7,786	0	27	199	122	0	320	4,478	1.1	14.0
400	0	2,377	0	8	61	28	0	88	1,269	1.1	14.3
168	0	1,452	0	5	37	17	0	54	782	1.1	14.5
401	0	1,452	0	5	37	17	0	54	782	1.1	14.5
131	0	726	0	2	19	34	0	53	782	1.1	14.9
170	1	4,785	0	16	122	112	0	234	3,524	1.1	15.0
101	0	1,919	0	7	49	39	0	88	1,359	1.1	15.5
TOTAL	54	264,518	0	902	6,745	5,594	0	12,339	162,986	1.1	13.2

TABLE 3-14 (Continued)
ECO 5, INSTALL HIGH EFFICIENCY ELECTRIC MOTORS

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
171	1	4,167	0	14	106	132	0	238	3,868	0.9	16.3
500	1	11,607	0	40	296	153	0	449	7,782	0.9	17.3
184	1	10,820	0	37	276	127	0	403	7,160	0.9	17.8
100	0	1,044	0	4	27	12	0	39	684	0.9	17.6
040	0	1,009	0	3	26	12	0	38	695	0.8	18.5
041	0	1,585	0	5	40	19	0	58	1,153	0.8	19.6
042	0	1,534	0	5	39	24	0	63	1,330	0.7	21.0
022	0	610	0	2	16	14	0	30	684	0.7	22.9
155	0	1,051	0	4	27	25	0	51	1,261	0.6	24.5
522	0	1,044	0	4	27	24	0	51	1,368	0.6	26.8
061	0	1,026	0	3	26	24	0	50	1,379	0.5	27.5
358	1	3,000	0	10	77	70	0	147	4,118	0.5	28.0

3.4.6 ECO 6 - ECONOMIZERS

Premise:
This ECO involves using outside air economizers on air handling units (AHUs) to optimize the use of "free" outside air for cooling, to maintain comfort conditions within the space, whenever possible.

Field Survey:
AHUs were surveyed to determine outside, return, and relief air dampers and controls, including measurements or estimates of minimum ventilation rates on selected buildings.

Basis for Analysis:
Economizers consist of controlling return air, outside air, and relief air dampers to provide "free" outside air for cooling, whenever possible. The economizer controls set the dampers to provide 100% outside air when outside air temperatures are capable of satisfying the cooling load. As outside air temperatures drop, the dampers are modulated to provide the required mixed air temperature. When outside air temperatures are above the temperature required to satisfy the cooling load, outside air is modulated to the minimum required for ventilation. The actual demand for cooling is considered in optimizing of damper controls.

The amount of energy which can be saved is limited by:

- The six month operating schedule of the cooling systems.
- Outside air temperatures during the cooling season, which are rarely cool enough to satisfy the inside cooling load.
- Operation of the economizers throughout the heating season, which will also improve occupant comfort during the heating season, when buildings often overheat, but can increase heating loads. (This analysis assumes economizer operation only during the cooling season.)

Installation of an economizer requires installation of linked return air and outside air dampers and operators, with specialized dry bulb economizer controls. In some cases, one or more of these dampers may already exist. Additional duct work may be required to bring in outside air and expel relief air. The dry bulb economizer control must be interfaced into the existing control system.

Energy Savings Calculations:
The baseline condition was simulated by computer for typical buildings, using either measured or design ventilation rates. When no information was available on ventilation rates, a standard minimum ventilation rate of 20 cfm per person was used. This ECO was evaluated using the dry bulb economizer control strategy, as described above.

3.4.6 ECO 6 - ECONOMIZERS (Continued)

Energy Savings Calculations: (Continued)
Economizer energy savings for the typical buildings were extrapolated to obtain savings for similar buildings, based on the following assumptions:

- An economizer should carry the same fraction of the cooling load for similar buildings.
- Similar buildings have the same cooling load per square foot of floor area.

Table 3-15 on page 3-39 contains the results of analysis of this ECO.

Results: There were no buildings with an SIR greater than 1.0.

Recommendations: Do not implement.

TABLE 3-15
ECO 6, ECONOMIZERS

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
181	0	6,198	0	21	158	0	0	158	19,688	0.1	124.6
184	0	4,737	0	16	121	0	0	121	18,746	0.1	155.2
246	0	1,570	0	5	40	0	0	40	30,708	0.0	767.0
514	0	305	0	1	8	0	0	8	25,461	0.0	3273.7

3.4.7 ECO 7 - CONTROL HOT WATER CIRCULATION PUMP

Premise:
This ECO involves controlling the hot water and DHW circulation pumps to minimize pump operation.

Field Survey:
Nameplate data were recorded and operating sequences were determined for the hot water and DHW circulation pumps in selected buildings. The DHW pumps run continuously all year round, but the hot water pumps run continuously during the heating season and are turned off at other times.

Basis for Analysis:
Circulation pumps are used to pump conditioned water to various areas in a building. Many times during the heating season these pumps are not used, such as during unoccupied periods with night setback, or when heating loads are met by other means. During these times, they can be turned off, thereby saving energy. For the purpose of this analysis, the pump was cycled on and off according to heating demand. Space temperature setpoints were lowered during unoccupied periods (night setback mode).

Optimization controls would be installed to shut off the circulation pumps during unoccupied periods and when heating loads are met in the building. These controls would optimize the operation of the pumps by using a building occupancy schedule and space temperature sensors to determine if there is a need for heating. An outside air temperature sensor would also be included, to determine the optimum start and stop times.

Energy Savings Calculations:
Electrical energy savings are the difference between the existing energy consumption (pump running continuously) and the improved energy consumption (pump cycled to meet heating demand). Boiler electrical consumption is included.

Heating energy savings will be achieved because the controls installed to cycle the pump will also be able to implement a night setback of the space temperature setpoints. These savings are the difference between the existing energy consumption (constant space temperature setpoint) and improved energy consumption (setpoint lowered during occupied periods). The following equations were used:

Pump Electric Usage	=	(electric load) x (hours of operation)
Electric Savings	=	existing electric usage - improved electric usage
Gas Savings	=	existing gas usage - improved gas usage

Table 3-16 on page 3-42 contains the results of analysis of this ECO.

3.4.7 ECO 7 - CONTROL HOT WATER CIRCULATION PUMP (Continued)

Results: (Combined results for buildings with SIR greater than 1.0)

Annual Natural Gas Savings (MBtu)	876
Annual Electrical Energy Savings (kWh)	128,957
Annual Demand Savings (kW)	0
Annual Non-Energy Cost Savings	$0
Total Annual Cost Savings	$7,379
Estimated Construction Cost	$33,008
Analysis Period (years)	15
Simple Payback (years)	4.5
Savings-to-Investment Ratio (SIR)	2.9

Recommendation: Implement.

TABLE 3-16
ECO 7, CONTROL HOT WATER CIRCULATION PUMP

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
500	0	33,679	378	493	2,624	0	0	2,624	11,003	3.2	4.2
171	0	47,639	249	411	2,385	0	0	2,378	11,003	2.8	4.6
170	0	47,639	249	411	2,385	0	0	2,378	11,003	2.8	4.6
Total	0	128,957	876	1,316	7,406	0	0	7,379	33,008	2.9	4.5
184	0	6,245	120	141	720	0	0	720	11,003	0.9	15.3

3.4.8 ECO 8 - INSTALL LOW-FLOW AND FAUCET FIXTURES

Premise:
This ECO involves replacing shower heads and faucets with low-flow shower heads and faucets to minimize hot water consumption.

Field Survey:
Shower and faucet flow rates on selected buildings were measured. Low-flow shower heads and faucets were then installed and the flow rates remeasured. Flow rates as high as 5.6 gpm were measured.

Basis for Analysis:
Standard shower heads and faucets use more hot water than necessary. The heating of this extra water increases building energy and water consumption.

Energy Savings Calculations:
The energy savings was found by calculating the energy needed to heat the water for existing shower heads and faucets, and subtracting the energy required for low-flow shower heads and faucets. Water savings were calculated in the same manner.

Existing Annual Usage	=	(no. of people) x (gpm_p) x (usage time)
Low-Flow Annual Usage	=	(no. of people) x (gpm_{lf}) x (usage time)
Annual Energy Savings	=	(present gal per yr - low-flow gal per yr) x (8.33) Cp x (shower water temperature - supply water temperature)/eff

where:

No. of people	= Occupants in building
gpm_p	= Present gallons per minute
gpm_{lf}	= Low-flow gallons per minute
Usage time	= Minutes of usage per year
8.33	= lbs per gallon
Cp	= Specific heat of water, 1 Btu per lb °F
eff	= Efficiency of water heater; gas-70%, electric-100%
shower water temperature	= 102°F
supply water temperature	= 66°F

Table 3-17 on page 3-45 contains the results of analysis of this ECO.

3.4.8 ECO 8 - INSTALL LOW-FLOW SHOWER AND FAUCET FIXTURES (Continued)

Results: (Combined results for buildings with SIR greater than 1.0)

Annual Natural Gas Savings (MBtu)	1,001
Annual Electrical Energy Savings (kWh)	0
Annual Demand Savings (kW)	0
Annual Non-Energy Cost Savings	$6,495
Total Annual Cost Savings	$11,169
Estimated Construction Cost	$10,956
Analysis Period (years)	15
Simple Payback (years)	1.0
Savings-to-Investment Ratio (SIR)	12.4

Recommendation: Implement. The Government should consider implementing this ECO as an in-house maintenance project, or with an on-site job contractor.

TABLE 3-17
ECO 8, INSTALL LOW-FLOW SHOWER AND FAUCET FIXTURES

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
401	0	0	159	159	741	0	885	1,627	425	47.3	0.3
109	0	0	52	52	244	0	448	692	238	34.7	0.3
056	0	0	131	131	611	0	803	1,414	889	19.5	0.6
058	0	0	131	131	611	0	803	1,414	889	19.5	0.6
062	0	0	131	131	611	0	803	1,414	889	19.5	0.6
060	0	0	140	140	654	0	1,018	1,671	1,334	15.2	0.8
028	0	0	41	41	191	0	298	488	445	13.3	0.9
363	0	0	44	44	204	0	244	449	425	13.0	0.9
040	0	0	68	68	319	0	476	795	934	10.3	1.2
168	0	0	76	76	354	0	499	853	1,044	10.0	1.2
027	0	0	29	29	134	0	220	354	445	9.6	1.3
	Admin. Cost								3,000		
Total	0	0	1,001	1,001	4,674	0	6,495	11,169	10,956	12.4	1.0

3.4.9 ECO 9 - HEAT RECLAIM FROM HOT REFRIGERANT GAS

Premise:
This ECO involves reclaiming heat from hot refrigerant gas and using it for heating domestic hot water (DHW).

Field Survey:
Data from vapor compression cooling machines and DHW loads on selected buildings was collected.

Basis for Analysis:
Heat can be reclaimed from hot refrigerant gas via a refrigerant desuperheater which transfers heat from hot refrigerant gas to circulating water. The desuperheater would be installed in the hot gas piping between the compressor and condenser, where it precools the hot gas entering the condenser. Heat transfer is limited by the temperature of the hot gas, which does not normally exceed 160°F. The maximum practical water temperature which can be generated is about 140°F, ideal for DHW heating. Desuperheaters reclaim about 2,600 Btuh of heat per ton of refrigeration load in heating water from 75°F to 140°F.

The following factors influence the performance of the desuperheater:

- Refrigeration systems which operate year round will produce more hot water than refrigeration systems operating seasonally. Food refrigeration systems are ideal candidates, while space cooling systems are poor candidates.

- DHW loads must be substantial to justify the cost of installing a desuperheater. Office buildings are poor candidates, while food service facilities are good candidates.

Food service facilities typically have walk-in coolers with substantial refrigeration loads, and also have significant DHW loads. Buildings 133 (Fort Gillem) and 500 (Fort McPherson) are food service facilities; however, Building 500 was selected for analysis because it has a greater DHW load.

The hot refrigerant gas heat reclaim system consists of refrigerant desuperheaters on each refrigeration system, a DHW tank, a small pump, and insulated water piping. The 200-gallon storage tank is sized to store hot water generated at night when there is no consumption of hot water.

3.4.9 ECO 9 - HEAT RECLAIM FROM HOT REFRIGERANT GAS (Continued)

Energy Savings Calculations:
Building 500 is equipped with two 7.5 ton refrigeration systems serving two walk-in coolers. Assuming a 50% load factor, a desuperheater will heat 867 gallons of water per day from 75°F to 140°F. At an estimated 250 meals per day, the daily DHW usage is 600 gallons, with a DHW heating load of 286,000 Btu per day. The desuperheaters are thus capable of supplying the entire DHW load. Assuming a 75% efficiency for the existing gas water heater, the resulting annual energy savings is 139 MBtu. The desuperheater will require a small, 60-watt pump for water circulation, adding 526 kWh to the current annual electricity usage.

Table 3-18 on page 3-48 contains the results of analysis of this ECO.

Results: There were no buildings with an SIR greater than 1.0.

Recommendations: The best case evaluation of Building 500 indicates poor economics. Do not implement.

TABLE 3-18
ECO 9, HEAT RECLAIM FROM HOT REFRIGERANT GAS

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
500	0	0	158	158	738	0	0	738	16,579	0.6	22.5

3.4.10 ECO 10 - PREVENT AIR STRATIFICATION

Premise:
This ECO involves providing ceiling fans to lower warm air stratified in high bay ceilings to floor level, to be used for space heating.

Field Survey:
Measurements of air temperatures near the floor and near the ceiling were taken in Building 512 (Fort Gillem) to determine stratification. Temperatures at floor level were measured at 65°F, while temperatures near the ceiling were about 68°F.

Basis for Analysis:
The temperature stratification in a conditioned space depends upon:

- Air changes between the upper and lower portions of the space.
- Amount of insulation in the ceiling.

For the purposes of this study, the air changes between the upper and lower portions of the space were estimated at 8.4 air changes per hour (ACH), which is caused by:

- Natural convection.
- Unit heaters in the upper portion which blow air downward.

Installing ceiling fans to increase air changes between upper and lower portions will decrease stratification, thereby lowering the temperature in the upper portion, reducing heat losses through the roof, and saving energy.

Two options for ceiling fans were evaluated:

- Blade-type industrial ceiling fans delivering about 40,000 cfm with a power consumption of 145 watts.
- Four-way fans providing a choice of destratification, exhaust, or ventilation in a single unit. Four-way fans will deliver about 40,000 cfm with a power consumption of 7,300 watts.

Blade-type ceiling fans were selected over four-way fans for further analysis, because of the lower power consumption and lower cost.

One ceiling fan is required for each 5,000 square feet of floor area. Up to 15 ceiling fans may be controlled by a manual 10 amp, 220 volt switch. Installed cost of ceiling fans are estimated at $135 per 1000 square feet of floor area, including electrical service.

3.4.10 ECO 10 - PREVENT AIR STRATIFICATION (Continued)

Energy Savings Calculations:
Energy savings from ceiling fans were based on computer simulation of Building 336. The baseline condition was determined by simulation the building on the computer with the upper and lower portions of the space divided into two zones; the upper zone maintained at 68°F and the lower zone at 65°F.

Ceiling fans are typically sized for about 25 ACH, which would reduce stratification to about one-third of existing levels. Air temperatures in the upper portion of the space would be reduced from the current 68°F to 66°F while the lower portion would remain at 65°F. A second model was then created by lowering the upper zone temperature from 68°F to 66°F. Annual energy savings is the difference in energy consumption between the two models. Additional electricity consumption by the ceiling fans was calculated.

Table 3-19 on page 3-51 contains the results of analysis of this ECO.

Results: There were no buildings with an SIR greater than 1.0.

Recommendations: Do not implement.

TABLE 3-19
ECO 10, PREVENT AIR STRATIFICATION

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
366	0	(1,339)	11	6	17	0	0	17	678	0.5	39.7

3.4.11 ECO 11 - REPLACE STREET LIGHTS

Premise:
This ECO involves reducing lighting levels from street lights and replacing street light bulbs with higher efficiency bulbs where applicable.

Field Survey:
A visual inspection of the street lights was performed before daylight to determine relative lighting levels. The type of lamp in each fixture was noted. During the field survey, no excessively lit areas were observed. Existing lighting levels are in the 0.1 to 1.5 footcandle range. Recommended street lighting levels are 0.5 to 2.0 footcandle range. Fort McPherson is presently operating on minimal street lighting; therefore, light reduction is not recommended. However, some existing bulbs could be replaced with higher efficiency high-pressure sodium (HPS) or metal halide bulbs.

Basis for Analysis:
Replacing low-efficiency mercury vapor and quartz bulbs with higher efficiency HPS bulbs can save energy. The list below indicates the proposed bulb replacements:

Now in use	Lumens per bulb**	Proposed change*	Lumens per bulb**
175 Watt Mercury Vapor	8,000	150 Watt HPS	13,000
400 Watt Mercury Vapor	20,000	360 Watt HPS	35,000
1500 Watt Quartz Lamp	35,800	400 Watt HPS	45,000
500 Watt Quartz Lamp	20,000	200 Watt HPS	19,800

Replacing quartz bulbs with higher efficiency HPS bulbs will also have non-energy labor savings, because quartz bulbs have a shorter life than HPS bulbs.

* Source: The Energy Saver's Guide to Good Outdoor Lighting, published by the National Lighting Bureau.

** Approximate vertical lumens reflect initial light output (Sylvania Large Lamp Catalog).

3.4.11 ECO 11 - REPLACE STREET LIGHTS (Continued)

Energy Saving Calculations:
The savings realized from replacing low-efficiency bulbs with higher efficiency bulbs is calculated by:

Electrical Demand (kW)	=	(present bulb wattage-replacement bulb wattage) x (number of bulbs)/1000
Energy Reduction (kWh)	=	(Electrical Demand x hours "ON" per year)
Hours "ON" per year	=	3,285 hours

Table 3-20 on page 3-54 contains results of the analysis of this ECO.

Results: (Combined results for lighting with SIR greater than 1.0)

Annual Natural Gas Savings (MBtu)	0
Annual Electrical Energy Savings (kWh/yr)	43,362
Annual Demand Savings (kW/yr)	0
Annual Non-Energy Cost Savings	$417
Total Annual Utility Cost Savings	$1,527
Estimated Construction Cost	$6,917
Analysis Period	25
Simple Payback	3.4
Savings-to-Investment Ratio (SIR)	4.5

Recommendation: Implement.

TABLE 3-20
ECO 11, REPLACE STREET LIGHTS

Exist. Bulb	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
1500W Quartz	0	43,362	0	148	1,110	0	417	1,527	6,917	3.4	4.5
500W Quartz	0	0	0	0	9	0	0	0	0	--	--
400W M.Vapor	0	788	0	3	20	0	0	20	529	0.6	26.2
175W M.Vapor	0	1,971	0	7	50	0	0	50	1,793	0.4	35.5

3.4.12 ECO 12 - REVISE OR REPAIR HVAC CONTROLS

Premise:
This ECO involves repairing or modifying HVAC controls, or installing new HVAC controls in selected buildings, as appropriate.

Field Survey:
Information was gathered about operating conditions, equipment, and controls in the selected buildings. The majority of these controls are in poor condition: time clocks are not set; controls have been rewired; and generally, the controls are not operating properly.

Basis for Analysis:
HVAC systems with poorly operating controls are inefficient. These systems often operate when not needed, or over-condition spaces, thereby wasting energy.

Following is a list of buildings and the proposed control modifications.

Buildings 060-056, 058, 062:
These barracks, with two pipe fan coil units (FCU), are continuously occupied; therefore, it is not feasible to shut down the fans. The proposed control strategy would provide direct digital control of the heating and cooling coils to regulate space temperature, reset chilled water and hot water supply temperature, and shut down the dual temperature pump and fans between the heating and cooling seasons.

Buildings 100-101:
These dental clinics are occupied on weekdays, for eight hours per day. The proposed control strategy for these buildings is to provide direct digital control to turn off AHUs, pumps, chillers, and boilers during unoccupied periods, control of heating and cooling coils, regulate space temperatures, and reset chilled water and hot water supply temperatures.

Building 168:
The upstairs portion of this building is used for visiting officers quarters, while the downstairs is used for administration. Fan coils serve both areas. The proposed control strategy is to provide direct digital control to shut off downstairs fan coils using night setback and low limit temperature setpoints. Between seasons, FCUs, pumps, chillers, and converters would be turned off.

Buildings 131, 171, 170:
These medical clinics are occupied on weekdays, eight hours per day. The proposed control strategy for these buildings is to provide direct digital control to shut off fan coils using night setback and low limit temperature setpoints, and to shut off FCUs, pumps, chillers, and converters between seasons and during unoccupied periods.

3.4.12 ECO 12 - REVISE OR REPAIR HVAC CONTROLS (Continued)

Building 181:
This building is occupied on weekdays, eight hours per day. The proposed control strategy for this building is to provide direct digital control to turn off AHUs, pumps, chillers, and boilers during unoccupied periods, control of heating and cooling coils, regulate space temperatures, and reset chilled water and hot water supply temperatures.

Building 184, 246:
These administrative buildings are occupied on weekdays, eight hours per day. The control strategy for these buildings is to provide direct digital control of the hot deck and cold deck coils, modulate zone dampers to maintain occupied and unoccupied heating and cooling setpoints, and to optimize run times of the AHUs, circulation pumps, chillers, boilers, and converters, based on the occupancy schedule and the heating and cooling demand.

Building 200:
Under current conditions, the supply fans for the upper floors of the building operate from 0400 hours to 2100 hours and maintain a constant outside air ventilation rate of 45,500 cfm, or approximately 20 cfm per person; and the supply fans for the basement operate 24 hours a day. For energy savings operation, the ventilation levels of the upper floors would be reduced during lower occupancy periods. However, the ventilation levels of the basement would not be reduced, due to the basement being continuously occupied at a 100% occupancy level. The ventilation control would be accomplished by using the existing EMCS to control the ventilation dampers to provide the following outside air percentages (of 45,500 cfm):

0000 hours to 0400 hours	0%
0400 hours to 0600 hours	25%
0600 hours to 1800 hours	100%
1800 hours to 2100 hours	25%
2100 hours to 2400 hours	0%

Building 358:
This administration building is occupied on weekdays, eight hours per day. The proposed control strategy for this building is to provide direct digital control of heating and cooling coils to maintain occupied and unoccupied heating and cooling setpoints, and to optimize run times of the AHUs, circulation pumps, chillers, and boilers, based on the occupancy schedule and heating and cooling demand.

Building 500:
This officers club is occupied on weekdays and evenings, and sometimes on Saturday afternoons and evenings. The proposed control strategy for this building is to provide direct digital control of heating and cooling coils to maintain occupied and unoccupied heating and cooling setpoints, and to optimize run times of the AHUs, circulation pumps, chillers, and boilers, based on the occupancy schedule and the heating and cooling demand.

3.4.12 ECO 12 - REVISE OR REPAIR HVAC CONTROLS (Continued)

Building 514:
This daycare center is occupied on weekdays. The proposed control strategy for this building is to provide direct digital control of heating and cooling coils to maintain occupied and unoccupied heating and cooling setpoints, and to optimize run times of the AHUs, circulation pumps, and chillers, based on the occupancy schedule and heating and cooling demand.

Energy Savings Calculations:
Buildings were grouped by similarity. A typical building from each group was simulated by computer to create a baseline model. A second model was created to simulate the proposed control modifications to the building. The annual energy savings for each typical building is the difference in energy consumption between the two models. The savings for the typical buildings was extrapolated for the other buildings in each group. The following equations were used:

Electrical Savings	= Baseline electrical usage - improved electrical usage
Demand Savings	= Baseline electrical demand - improved electrical demand
Gas Savings	= Baseline gas usage - improved gas usage

Six hours per year labor savings (non-energy) were estimated for a reduction in temperature-related (too hot, too cold) work orders. Table 3-21 beginning on page 3-58 contains the results of analysis of this ECO.

Results: (Combined results for buildings with SIR greater than 1.0)

Annual Natural Gas Savings (MBtu)	1,386
Annual Electrical Energy Savings (kWh)	1,380,662
Annual Demand Savings (kW)	93
Annual Non-Energy Cost Savings	$1,143
Total Annual Cost Savings	$52,327
Estimated Construction Cost	$273,301
Analysis Period (years)	15
Simple Payback (years)	5.2
Savings-to-Investment Ratio (SIR)	2.2

Recommendation: Implement.

TABLE 3-21
ECO 12, REVISE OR REPAIR HVAC CONTROLS

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
171	26	193,390	262	921	6,155	2,669	127	8,951	24,886	4.1	2.8
170	23	171,230	232	816	5,450	2,363	127	7,940	28,402	3.2	3.6
131	22	160,374	217	764	5,104	2,213	127	7,445	31,919	2.7	4.3
181	0	249,984	202	1,054	7,318	0	127	7,445	41,867	2.0	5.6
246	0	181,411	42	661	4,822	0	127	4,949	27,815	2.0	5.6
500	4	173,997	413	1,006	6,366	411	127	6,903	45,699	1.8	6.6
101	8	113,894	0	389	2,906	822	127	3,885	24,599	1.7	6.4
514	5	65,286	17	240	1,744	513	127	2,384	23,514	1.1	9.9
100	5	71,096	0	243	1,814	513	127	2,454	24,599	1.1	10.0
Total	93	1,380,662	1,386	6,094	41,678	9,505	1,143	52,327	273,301	2.2	5.2

TABLE 3-21 (Continued)
ECO 12, REVISE OR REPAIR HVAC CONTROLS

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
184	1	116,277	120	517	3,525	103	127	3,755	52,733	0.8	14.0
358	15	40,348	7	144	1,061	1,540	127	2,728	38,666	0.8	14.2
168	2	31,210	19	125	885	205	127	1,217	24,886	0.5	20.4
060	5	15,696	84	138	793	513	127	1,433	61,950	0.3	43.2
062	4	12,093	65	106	611	395	127	1,133	47,883	0.3	42.3
056	4	11,756	63	103	594	384	127	1,105	47,883	0.3	43.3
058	4	11,967	64	105	604	391	127	1,123	47,883	0.3	42.7
200*	0	(3,423)	0	(12)	(87)	0	0	(87)	--	--	--

* Ventilation control indicates negative savings if implemented.

3.4.13 ECO 13 - THERMAL STORAGE

Premise:
This ECO evaluates using thermal storage systems for reducing electric demand. Chillers could produce ice at night to be used for space cooling during daytime peak electric demand hours. Chillers could, therefore, be turned off during peak electric demand hours, thus reducing demand charges.

Field Survey:
The field survey included collection of all necessary data to evaluate the ECO.

Basis for Analysis:
Based on historical electrical demand data, peak post demand occurs between the hours of 1200 hours and 1600 hours on weekdays. Computer simulations of typical office buildings at the fort indicate 30% of the afternoon peak electric demand can be attributed to space cooling equipment. Since demand charges throughout the year are based on the summertime peak electrical demand, reducing actual peak summer electrical demand will reduce electrical demand costs year round.

It is proposed to install a modular ice bank thermal storage system with a dedicated chiller. The system would supplement the existing chiller. Ice would be generated between 1800 and 0600 hours to be used for cooling between 1200 and 1600 hours. The existing chiller would be used to generate chilled water during the remaining hours of the day.

Utility Savings Calculations:
Using a building simulation computer program, a baseline model for energy consumption was established for each building. A second model was created, incorporating the thermal storage system. The annual energy savings is the difference in energy consumption between the two models.

Thermal storage does not save energy; rather, it shifts electrical demand to night time, thus leveling electrical demand and reducing electrical demand charges. Energy usage is slightly increased due to additional chiller power consumption in generating chilled brine at 25°F rather than chilled water at 42°F.

Table 3-22 on page 3-61 contains the results of analysis of this ECO.

Results: There were no buildings with an SIR greater than 1.0.

Recommendations: Do not implement.

TABLE 3-22
ECO 13, THERMAL STORAGE

Bldg.	Peak Demand Savings (kW)dt	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
60	22	(9,399)	0	(32)	(240)	2,259	0	2,019	65,144	0.3	32.3
170	60	(16,296)	0	(56)	(416)	6,160	0	5,744	154,372	0.4	26.9
171	60	(16,296)	0	(56)	(416)	6,160	0	5,744	154,372	0.4	26.9
181	52	(33,926)	0	(116)	(865)	5,338	0	4,473	128,420	0.4	28.7
184	66	(19,857)	0	(68)	(506)	6,776	0	6,269	128,420	0.5	20.5
200	673	(138,284)	0	(472)	(3,526)	69,090	0	65,564	1,165,056	0.6	17.8
246	83	(19,847)	0	(68)	(506)	8,521	0	8,015	91,709	0.9	11.4
500	46	(13,122)	0	(45)	(335)	4,722	0	4,388	128,420	0.4	29.3

3.4.14 ECO 14 - RADIANT HEATERS AND LOADING DOCK SEALS

3.4.14.1 ECO 14 - Radiant Heaters

It was determined this ECO is not applicable in the buildings to be evaluated. The buildings investigated were either to be remodeled into areas where radiant heaters were not applicable, or the facility had minimal existing heating available, thus minimizing savings.

3.4.14 ECO 14 - RADIANT HEATERS AND LOADING DOCK SEALS

3.4.14.2 ECO 14 - Loading Dock Seals

It was determined this ECO is not applicable in the buildings to be evaluated. There were no loading docks where seals would provide a reduction in infiltration, lowering heating usage.

3.4.15.1 ECO 15 - SEPARATE LIGHT SWITCHES

Premise:
This ECO involves adding switches, either manual or occupancy sensor type, to reduce the operating hours of lighting.

Field Survey Notes
The field survey team observed and noted the following conditions in each building.

Room Number - if the number was not clearly marked on the plans or near the actual room, EMC assigned a number for that room, depending on its location, and a CAD sketch of the building, including room numbers, was provided.

Number of Fixtures- total number of fixtures per room.

Fixture Type - brief description of lighting fixture type (i.e., fluorescent, incandescent, metal halide).

Watts per Fixture - estimated wattage per fixture.

On or Off During Survey - whether the light was on or off during the survey.

Switch Yes or No - whether the lighting has local switch(es).

Number of Switches - number of light switches.

Unoccupied, Lights "ON" - whether the lights were turned on in an unoccupied room.

Good for Occupancy Sensor - whether the physical configuration of the light switch and room makes it a good candidate for an occupancy sensor type light switch.

Basis for Analysis:
Currently, interior lighting is left on, either because no local switching is available (only circuit breakers) or because people do not turn the lights off when they leave their offices for short periods of time. Providing light switches can save energy. For the purposes of this study, two types of lighting controls were reviewed for improving light controls:

- Occupancy sensor type light switches
- Manual light switches

3.4.15.1 ECO 15 - SEPARATE LIGHT SWITCHES (Continued)

Basis for Analysis: (Continued)
Occupancy sensor type light switches can provide the greatest potential savings, by automatically shutting lights off in areas which are unoccupied. The configuration of the room, the location of the existing light switch, and the number of fixtures in the room determine the type of occupancy sensor which should be installed. The savings calculations were based on 19% of the lights, which would have otherwise been left on during normal occupied hours, being turned off by the occupancy sensor light switches.

For the purposed of this study, it was assumed a small office with less than four light fixtures could have occupancy sensors installed directly in place of the existing light switch. For a larger, open area, with four or more fixtures, an overhead occupancy sensor with relay controls would be required. In large, open areas with modular furniture panel systems, which currently have no switching, manual light switches would be provided for every six light fixtures. This approximates the design standards in Department of Energy Standard 10 CFR Part 435.

Savings calculations for large open areas assume lights are left on unnecessarily one extra hour per day, five days per week, because there are no lighting switches other than circuit breakers.

Energy Savings Calculations
A combination of spreadsheet and computer simulations was used to estimate the power and energy savings for lighting and air-conditioning, and the additional costs for heating. The lighting savings were determined room-by-room using spreadsheets. Air-conditioning and heating savings and costs due to a reduction in lighting, were determined by computer simulation. The typical building baseline model was made, then a second model was made to simulate the reduction in lighting loads. The difference of electrical and gas energy consumptions is the electrical savings and gas costs, respectively. The results for typical buildings were extrapolated for similar buildings.

In areas where occupancy sensor controls are proposed, the following utility savings calculation method was used:

<u>Percent Unoccupied Lights "ON" (A)</u> = 19% - average of all buildings surveyed.

<u>Hours "ON" per Year (B)</u> = The annual hours lights are "ON" is based on building occupancy schedule.

3.4.15.1 **ECO 15 - SEPARATE LIGHT SWITCHES** (Continued)

Energy Savings Calculations (Continued)

<u>Lighting kW Saved (C)</u> = The total lighting demand (kW) x (A)

<u>Lighting kWh Saved per Year (D)</u> = (B) x (C)

<u>Total Gas Increase (MBtu)</u> = (D) x (natural gas increase energy factor)

<u>Total kWh Saved per Year</u> = (D) x (electric saving energy factor)

Table 3-23 on page 3-66 contains the results of analysis of this ECO.

Results: (Combined results for buildings with SIR greater than 1.0)

Annual Natural Gas Savings (MBtu)	(25)
Annual Electrical Energy Savings (kWh)	46,857
Annual Demand Savings (kW)	13
Annual Non-Energy Cost Savings	$0
Total Annual Cost Savings	$2,445
Estimated Construction Cost	$28,173
Analysis Period (years)	25
Simple Payback (years)	11.5
Savings-to-Investment Ratio (SIR)	1.3

Recommendations: Implement.

TABLE 3-23
ECO 15, SEPARATE LIGHT SWITCHES

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
041	1	3,415	(1)	11	84	87	0	171	1,358	1.9	7.9
101	2	7,464	(1)	24	184	205	0	389	3,401	1.7	8.7
401	0	1,946	(0)	6	48	29	0	77	669	1.7	8.7
246	2	8,407	(3)	26	200	216	0	415	4,313	1.4	10.4
170	1	9,446	(1)	31	234	149	0	383	4,338	1.3	11.3
366	0	257	(0)	0	4	8	0	12	167	1.0	13.9
171	7	15,922	(18)	37	322	674	0	997	13,926	1.0	14.0
Total	13	46,857	(25)	135	1,077	1,368	0	2,445	28,173	1.3	11.5

TABLE 3-23 (Continued)
ECO 15, SEPARATE LIGHT SWITCHES

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
363	5	20,296	(39)	31	338	524	0	860	13,557	0.8	15.7
181	0	946	(0)	3	24	28	0	52	1,075	0.7	20.8
400	1	6,537	(1)	21	161	72	0	233	9,362	0.4	40.2
184	0	10,070	(5)	30	235	45	0	280	15,085	0.3	53.8
060	0	2,382	(4)	4	42	44	0	86	4,751	0.2	55.4
056	0	185	(0)	0	3	0	0	3	883	0.0	304.9
058	0	185	(0)	0	3	0	0	3	883	0.0	304.9
062	0	185	(0)	0	3	0	0	3	883	0.0	304.9

3.4.15.2 ECO 15 - AUTOMATIC LIGHTING CONTROLS IN BUILDING 200

Premise:
This ECO involves providing automatic lighting controls in Building 200 to reduce electrical usage.

Field Survey:
The field survey included tabulation of lighting in the building and observation of use patterns. In Building 200, lighting currently remains on past normal occupancy periods.

Basis for Analysis:
Approximately 70% of the building floor area is comprised of open office areas (cubicles). These areas presently have lighting circuits controlled through low voltage relays mounted in panels adjacent to the building lighting panels. Master selector switches for control of lighting circuits are located in the office areas.

It is proposed to replace the existing low voltage lighting relay panels with new "lighting automation panels" (LAPS), using the following:

- Remote control via telephone for individual or all lighting control relays.
- Control by building automation system, which controls lighting according to preset schedule.
- Local control via existing manual selector switches.

The proposed system should not require additional wiring in the ceiling plenum.

An occupant could override direct digital controls for the block of lights over a given office cubical by dialing a three-digit telephone code. An average of 21 overhead fixtures are controlled by each relay-switch in these areas.

Lighting in closed offices constitutes approximately 30% of the building floor area and is controlled by wall switches near doors. It is proposed to replace wall switches with ceiling-mounted ultrasonic occupancy detectors. Occupancy sensor type and locations for mounting (wall or ceiling) would be tailored for each individual office.

Energy Savings Calculations:
The energy savings was determined by computer simulation. First, a baseline model was created; then a second model was created, as follows:

- Open office area lighting was reduced 15% by using programmable lighting controls.

3.4.15.2 ECO 15 - AUTOMATIC LIGHTING CONTROLS IN BUILDING 200 (Continued)

- Closed office lighting was reduced 30% by using occupancy sensor controls.
- Task lighting was not reduced.

Table 3-24 on page 3-70 contains the results of analysis of this ECO.

Results: (Combined results for buildings with SIR greater than 1.0)

Annual Natural Gas Savings (MBtu)	0
Annual Electrical Energy Savings (kWh)	761,510
Annual Demand Savings (kW)	163
Annual Non-Energy Cost Savings	$0
Total Annual Cost Savings	$36,152
Estimated Construction Cost	$142,464
Analysis Period (years)	25
Simple Payback (years)	3.9
Savings-to-Investment Ratio (SIR)	3.8

Recommendations: Implement.

TABLE 3-24
ECO 15, AUTOMATIC LIGHTING CONTROLS IN BUILDING 200

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
200	163	761,510	0	2,599	19,419	16,734	0	36,152	142,464	3.8	3.9

3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE

Premise:
Electrical billing demand at Fort McPherson accounted for a major portion of the total electrical charges in FY91. Fort McPherson should evaluate how billing demand could be reduced through load shedding and other load shifting applications.

Basis for Analysis:
Table 3-25 on page 3-76 lists the monthly billing demand and actual demand for FY91. Figure 3-1 on page 3-77 graphically depicts the 30-minute electrical demand interval readings for a typical winter week. Figure 3-2 on page 3-78 depicts a typical summer week. The demand readings were provided by Georgia Power account representatives. The FY91 actual demand for Fort McPherson ranged from a high of 8,176 kW in August 1991 to a low of 5,557 kW in November 1990.

The billing demand is calculated from the greatest of the following three criteria:

- Current monthly actual demand
- 95% of the highest demand during the previous June through September
- 60% of the highest demand during the previous October through May.

The billing demand during June, July, August, and September 1991, was based on the actual demand, because high temperature and humidity periods resulted in heavy air-conditioning loads. The billing demand for October 1990 through May 1991 was based on 95% of the highest demand in the previous summer months, a system which is referred to as "demand ratchet." The billing demand was never based on the highest demand set in October through May. See Section 2.2.1 for further evaluation and explanation of the electrical rate structure.

The analysis of billing demand, and a review of the 30-minute demand readings, suggest Fort McPherson should reduce demand by various available methods during summer weekdays, from 1200 to 1600 hours. This action will reduce billing demand (95% of the highest demand during the previous June through September).

To accomplish these reductions, Fort McPherson should consider the following six types of load reducing strategies:

- Load shedding
- Thermal storage systems
- Absorption or gas driven chiller systems
- Lighting control systems
- Power generation
- High efficiency electrical equipment.

3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE (Continued)

Load Shedding:
A computer-based Utility Control System (UCS) can control various electrical loads to better manage post demand. The UCS would monitor instantaneous post demand and calculate the demand at one-minute intervals. If the UCS predicted the electrical demand was to exceed a peak value limit (target), it would shed or cycle selected loads on a prescheduled priority basis, to reduce the connected load before the actual peak exceeds the target. The UCS could be programmed to provide, for example, eight load priority levels. In the load shed software, the lowest priority level would be shed before the load in the next higher priority level. Loads shed within a priority level would be rotated automatically, to avoid any load from always being shed first. All loads shed in the highest priority levels would be restored before loads in lower priority levels.

The UCS could incorporate one or both of the following:

- Hardwired UCS with dedicated fiber optic data transmission system
- One-way FM radio transmission UCS.

The hardwired UCS would utilize microprocessor-based remote control units (RCUs) mounted in each building or in groups of buildings located in close proximity. The electrical loads would be wired to an RCU. A central operator station at the DEH would allow for monitoring of the post demand and programming of the RCU with the required load shed parameters. A fiber optic data transmission system would be used to communicate between the RCUs mounted at buildings, the RCU mounted at the electrical substation, and the central operator station. Because of two-way communications, the equipment monitoring, temperatures, status, and other conditions could be monitored at buildings using this type of system. A typical application of this type of system is the control of building HVAC fans, chillers, pumps, and other major electrical loads.

A one-way FM radio transmission UCS would utilize a micro-processor based digital control unit (DCU) FM radio-controlled switch, designed to switch remote loads on and off in response to commands from a central operator station. The control signals for this UCS are transmitted via FM radio signals. DCUs can be field programmed with 256 individual addresses. This type of system does not have two-way communications and would not provide equipment status monitoring. However, it has the advantage of being less expensive when controlling numerous, small electrical loads which are remotely located throughout the post. A typical application of the DCU system is in controlling small air-conditioning direct expansion (DX) compressors and electric water heaters, such as that used for family housing units.

3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE (Continued)

Load Shedding: (Continued)
The family housing units at Fort McPherson were surveyed and it was determined there are a total of 108 heat pump DX compressor units, with a total of 751 kW load which could be load shed on a rotating basis.

Other electrical loads which could be shed include electric water heaters, swimming pool pumps, and electric clothes dryers.

Thermal Storage System:
Thermal storage systems can reduce electrical demand by generating a mass of cold liquid or ice during off peak electrical periods, then using this mass to meet cooling requirements during peak electrical periods.

The primary advantage of a thermal storage system is the ability to use lower time-of-day electricity rates and off-peak demand rates to produce cold liquid or ice, which can be used instead of chillers to provide cooling for HVAC equipment during peak electrical use. Fort McPherson does not have a "time-of-day" type of rate structure which can make thermal storage extremely attractive, but if the overall peak electrical demand can be reduced by shutting off chillers during peak summer periods, demand charges can be reduced for the whole year, due to demand charge ratchets.

Thermal storage systems are most effective when used with major air cooled or water cooled chiller systems. See ECO 13, Section 3.4.13, on page 3-60, for an evaluation of thermal storage systems for Fort McPherson.

Absorption or Gas Driven Chiller Systems:
Absorption or gas driven chiller systems can reduce electrical demand by generating chilled water for HVAC equipment using steam, hot water, or direct fired chiller equipment, all the time, or only during peak electrical periods. This approach would reduce the electrical demand used for cooling, and may be attractive, since Atlanta Gas Light has special rate structures for summer air-conditioning natural gas usage.

Absorption or gas driven chiller systems are most effective where major air or water cooled chiller systems are in operation.

Lighting Control Systems:
Automatic lighting controls can reduce electrical energy and electrical demand (see ECO 15, Section 3.4.15.1). An occupancy sensor type of control will automatically switch lighting based on the presence or absence of people in a room. When a person enters a room, the sensor automatically switches the lights on. The lights remain on as long as someone is in the room. When the room is unoccupied, the sensor automatically turns the lights off, after a few minutes of delay.

3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE (Continued)

Lighting Control Systems: (Continued)

The best applications for occupancy sensor light switches include:

- Private offices
- Restrooms
- Hallways
- Lounges
- Computer rooms
- Clerical areas
- Conference rooms
- Classrooms
- Warehouse aisles
- Storage rooms
- Copier rooms
- Loading docks

Power Generation:

Peak shaving, standby, and emergency generators can be utilized to generate part of the electrical demand during peak periods, thereby reducing the demand charges. The cost for generating electrical energy using this type of equipment is normally quite high, compared to purchasing the energy from Georgia Power directly; however, the reduction in demand charges for operating the generators for a minimum number of hours during peak summer months can offset the cost to operate the generator.

A number of standby and emergency generators at Fort McPherson are candidates for this purpose, if the organization using this power source agrees to substitute generator power.

Fort McPherson may also wish to consider installing a peak shaving generator, designed either to handle a specific set of loads (e.g., chillers, motors) in one building, or connected to the facility power grid. This would be most applicable to buildings with large electrical loads, such as major chiller equipment.

High Efficiency Electrical Equipment:

Utilizing high efficiency electrical equipment in place of standard or lower efficiency sources would reduce electrical demand if this equipment operates during the peak electrical demand periods. ECOs evaluated for this study describe the possible alternatives, including:

- ECO 19, Lighting replacements
- ECO 5, High efficiency motors
- ECO 18, Exit sign replacements.

These ECOs are generally applicable to most buildings and most systems at Fort McPherson.

3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE (Continued)

Miscellaneous Systems:
Utilizing gas appliances in place of electric appliances can reduce electric demand charges, if those items are utilized during a period when the post demand is peaking. An example would be to replace existing clothes dryers with gas clothes dryers. During the field survey of personnel quarters, it was noted electric clothes dryers are provided throughout. Natural gas was available in most buildings, and could be used for replacement clothes dryers.

Demand Side Management:
Georgia Power has submitted a plan to the State Public Utility Commission to provide "demand side management" incentives to owners for various conversions and systems operations which would reduce peak demand. This plan would provide the Government with financial incentives for all the items proposed, except for the absorption chiller system. See Section 2.5 for further discussions on the Georgia Power demand side management program.

Sample Calculation for Reducing Peak Demand:
Table 3-26 on page 3-79 contains a sample cost per kW saved of the various alternatives presented for reducing post demand. Of the sample alternatives evaluated, occupancy sensor lighting control has the lowest construction cost per kW saved in this example. A project to provide UCS control of family housing air-conditioning units is included in Table 3-27 on page 3-80.

3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE (Continued)

TABLE 3-25
FY91 HISTORICAL ELECTRICAL DEMAND - FT. McPHERSON

MONTH	ACTUAL DEMAND (kW)	BILLING DEMAND (kW)
Oct.	6,750	7,685
Nov.	5,557	7,685
Dec.	5,708	7,685
Jan.	6,377	7,685
Feb.	6,064	7,685
March	5,627	7,685
April	5,897	7,685
May	7,182	7,685
June	7,749	7,749
July	8,062	8,062
Aug.	8,176	8,176
Sept.	7,906	7,906

3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE (Continued)

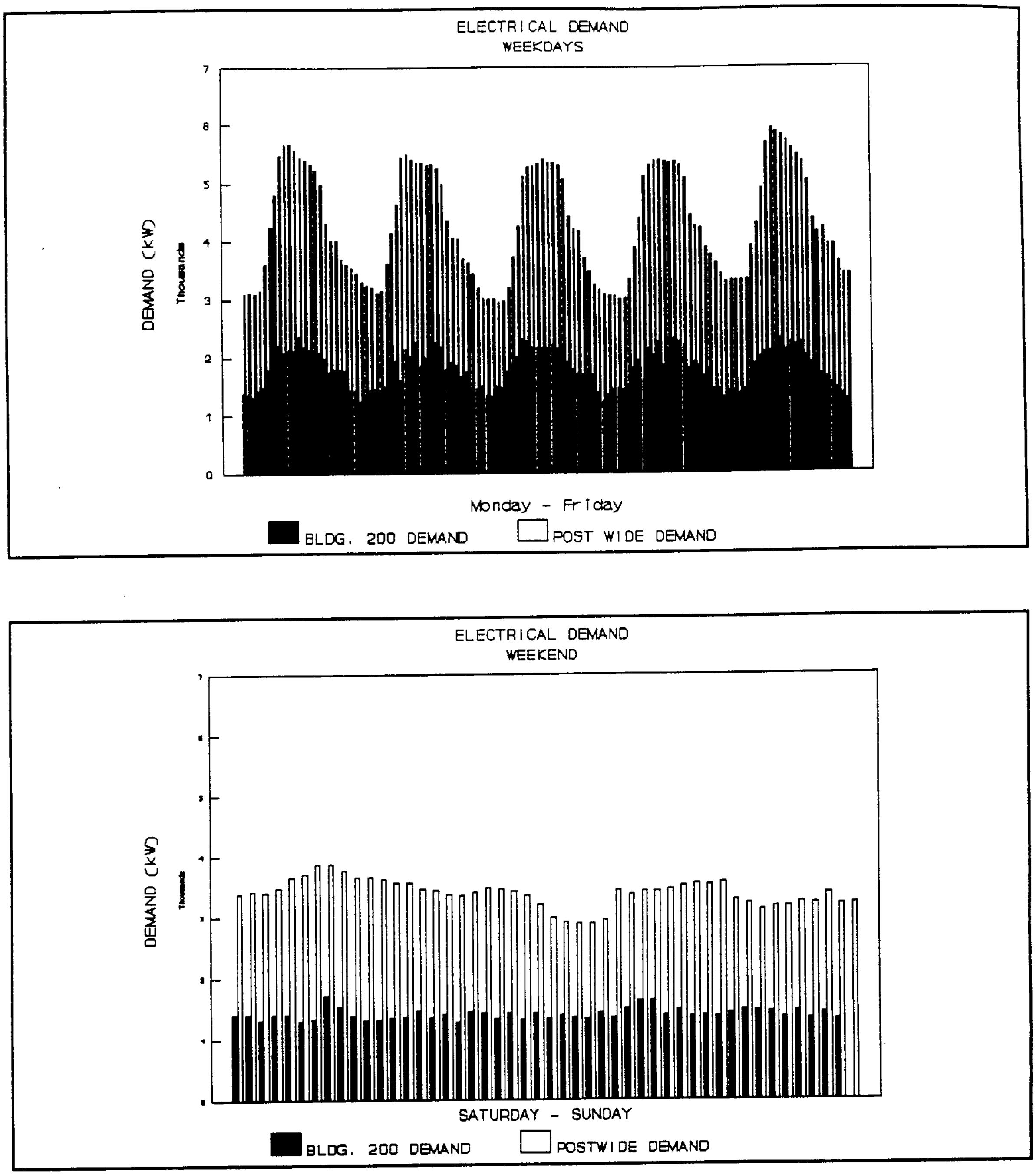
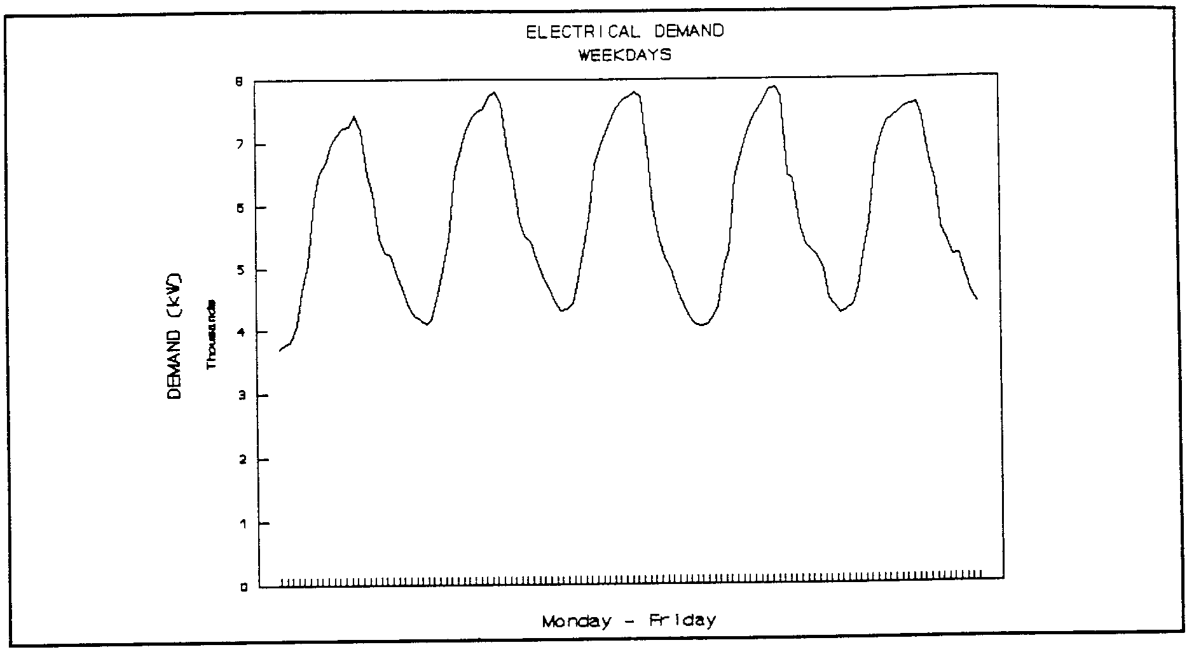


FIGURE 3-1
FY91 TYPICAL HOURLY DEMAND - FORT MCPHERSON
WINTER

3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE (Continued)



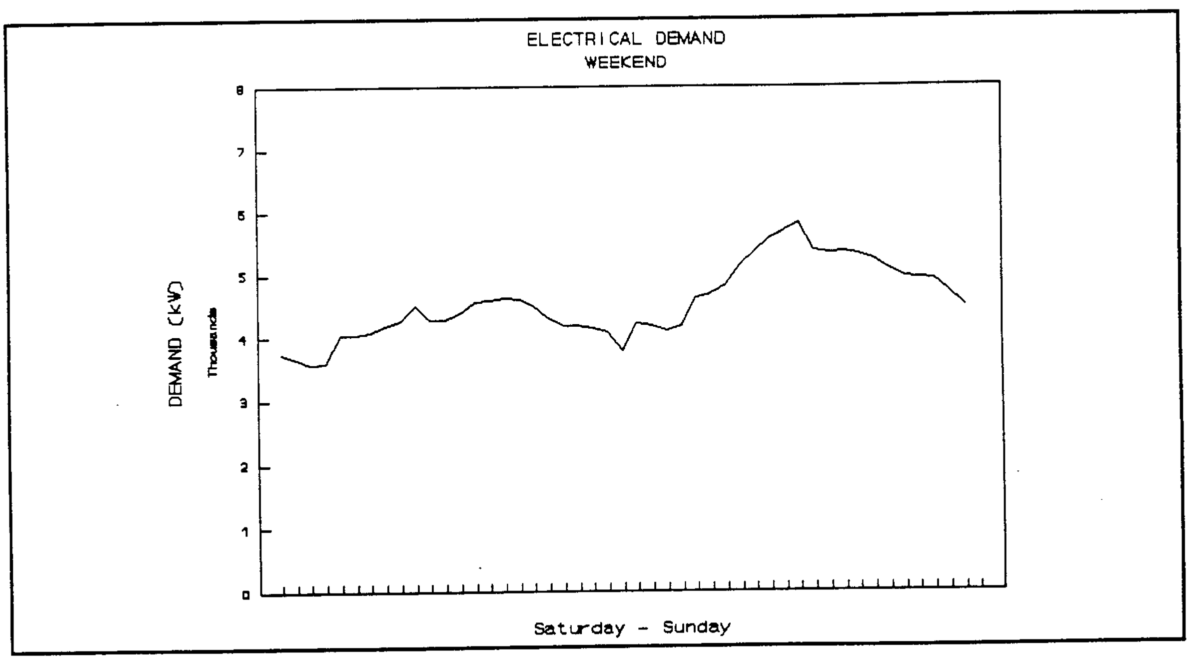


FIGURE 3-2
FY91 TYPICAL HOURLY DEMAND - FORT MCPHERSON
SUMMER

3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE (Continued)

TABLE 3-26
DEMAND SAVINGS COMPARISON

ALTERNATIVE FOR REDUCING PEAK DEMAND	CONSTRUCTION COST ($) PER kW SAVED
1. One-way FM radio transmission UCS, with 108 switches, 175 kW load	343
2. Ice storage system, 750 tons, 487 kW load	1,553
3. Natural gas engine driven chiller, 460 tons, 300 kW load reduction	1,334
4. Office occupancy sensor lighting control, 0.31 kW lights	210
5. Diesel engine generator set, 500 kW	260
6. High efficiency electric motor, 5 hp, .17 kW saved	4,124
7. Exit sign fluorescent lamp replacement kit, 10 kits, 0.3 kW saved	1,267

3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE (Concluded)

TABLE 3-27
FM RADIO CONTROL SYSTEM

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
N/A	214	0	0	0	0	21,983	0	21,983	81,982	2.8	3.7

3.4.17 ECO 17 - BOILER OPERATION SCHEDULE

The SOW did not indicate any buildings at Fort McPherson for evaluation of this ECO.

3.4.18 ECO 18 - REPLACE EXIT SIGN BULBS WITH FLUORESCENT BULB KIT

Premise:
This ECO involves replacing incandescent lamp exit signs with fluorescent bulb kits.

Field Survey:
Exit signs were counted and typical wattage ratings obtained.

Basis for Analysis:
It is assumed the existing exit signs are equipped with two 20 watt incandescent lamps, with an estimated lamp life of 10,000 hours. These bulbs could be replaced with a 9 watt fluorescent lamp pack, also having an estimated lamp life of 10,000 hours. No labor savings was accounted for. There would be a higher recurring cost to replace bulbs because the fluorescent lamps cost more than the existing lamps.

To accomplish the replacement, The existing exit signs must be grounded, metal framed, with incandescent bulbs. Minimum interior sign dimensions must be met.

Energy Saving Calculations:

kW Savings per fixture		= (Change in Watts)/1000
kWh Savings per fixture per year		= (Change in Watts) x (8760 hours per yr)/1000
Increased Recurring Cost per year ($)		= (($7.95) - (2*$2.25))*(8760 hr/10,000 hr)
		= $3.02/yr
Where:	Change in Watts	= Wattage of existing exit sign - Wattage of retrofit kit

Table 3-28 on page 3-83 contains the results of analysis of this ECO.

Savings per fixture:

kW Savings per year	= (40W-9W) x (12 months)/1000 = 0.372 kW/yr
kWh Savings per year	= (40W-9W) x (8760 hours/yr)/1000 = 271.56 kWh/yr

Results: (Combined results for buildings with SIR greater than 1.0)

Annual Natural Gas Savings (MBtu):	0
Annual Electrical Energy Savings (kWh/yr):	102,755
Annual Demand Savings (kW/yr):	12
Annual Non-Energy Cost Savings:	($1,181)
Total Annual Cost Savings:	$2,654
Estimated Construction Cost:	$16,567
Analysis Period:	25
Simple Payback:	6.2
Savings-to-Investment Ratio (SIR):	2.5

Recommendation: Implement.

TABLE 3-28
ECO 18, REPLACE EXIT SIGN BULBS WITH FLUORESCENT BULK KIT

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
041	0	1,051	0	4	27	12	(12)	27	169	2.5	6.2
056	0	3,154	0	11	81	37	(36)	181	508	2.5	6.2
058	0	3,154	0	11	81	37	(36)	181	508	2.5	6.2
060	1	4,468	0	15	114	52	(51)	115	720	2.5	6.2
062	0	3,154	0	11	81	37	(36)	81	508	2.5	6.2
101	0	3,154	0	11	81	37	(36)	81	508	2.5	6.2
170	0	5,256	0	18	135	62	(60)	136	847	2.5	6.2
171	1	5,782	0	20	148	68	(66)	149	932	2.5	6.2
181	1	7,884	0	27	202	92	(91)	204	1,271	2.5	6.2
184	1	6,307	0	22	161	74	(72)	163	1,017	2.5	6.2
200	3	26,280	0	90	673	308	(302)	679	4,237	2.5	6.2
246	1	5519	0	19	141	65	(63)	143	890	2.5	6.2
363	3	22,338	0	76	672	262	(257)	577	3,601	2.5	6.2
366	0	526	0	2	13	6	(6)	14	85	2.5	6.2
400	0	2,628	0	9	67	31	(30)	68	424	2.5	6.2
401	0	2,102	0	7	54	25	(24)	54	339	2.5	6.2
Total	12	102,755	0	351	2,631	1,204	(1,181)	2,654	16,567	2.5	6.2

3.4.19 ECO 19 - PREVIOUS LIGHTING STUDY REVIEW

Premise:
This ECO involves the review and updating of studies prepared by both Pacific Northwest Laboratory and Stone & Webster Engineering Corporation for shared energy savings (SES) lighting retrofit projects. The feasibility of a Government-funded lighting project is also evaluated.

Basis for Analysis:
<u>Feasibility Analysis for a Shared Energy Savings Lighting Retrofit in Building 200 at Ft. McPherson</u>, by Pacific Northwest Laboratory, January 1991.

This report determined the applicability and cost-effectiveness of an SES lighting project at Fort McPherson (Buildings 200, 246, 122, 184, 65, 358, and 170). The project proposed to retrofit the existing fluorescent fixtures with: 1) optical reflectors; 2) optical reflectors and cathode-cutout ballasts; 3) optical reflectors and electronic ballasts; or 4) to replace the existing fixtures entirely with new fixtures incorporating glare reducing parabolic louvers and cathode-cutout ballasts. The report recommended against the SES lighting retrofit project because the resulting light reduction would bring lighting levels below the minimum acceptable standards in the majority of the facilities. Based on this conclusion, this project was determined not to be feasible for Government funding.

<u>Feasibility Study for Lighting Shared Energy Savings Project, Ft. McPherson and Ft. Gillem, Georgia</u>, by Stone & Webster Engineering Corporation, July 1990.

This report considered the viability of an SES lighting project at Fort McPherson, Building 200 and offices, and Fort Gillem, warehouses and offices. In the office areas, the existing fixtures were recommended for replacement with new, more efficient fluorescent fixtures having approximately the same or higher illuminance levels. In the warehouse areas, the existing fluorescent system was recommended for replacement with a new, more efficient, HPS system which would deliver the same or higher illuminance levels.

Table 3-29 on page 3-86 contains the results of analysis of this ECO.

Energy Savings Calculations:
In the Pacific Northwest Laboratory report, the project was determined not to be technically feasible; therefore, no further analysis was performed on the report results.

3.4.19 ECO 19 - PREVIOUS LIGHTING STUDY REVIEW (Continued)

Energy Savings Calculations: (Continued)
Further analysis was performed on the project proposed in the Stone & Webster report. Construction costs were escalated using the Military Construction Program (MCP) to yield new energy savings at current rates.

Results: (Combined results for buildings with SIR greater than 1.0)

Annual Natural Gas Savings (MBtu)	0
Annual Electrical Energy Savings (kWh)	1,467,180
Annual Demand Savings (kW)	627
Annual Non-Energy Cost Savings	$0
Total Annual Cost Savings	$101,781
Estimated Construction Cost	$718,703
Analysis Period (years)	25
Simple Payback (years)	7.1
Savings-to-Investment Ratio (SIR)	2.1

Recommendation: Implement.

TABLE 3-29
ECO 19, PREVIOUS LIGHTING STUDY REVIEW

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
CCF	331	774,540	0	2,641	19,751	33,980	0	53,731	297,132	2.7	5.5
Office	296	692,640	0	2,362	17,662	30,387	0	48,050	421,571	1.7	8.8
Total	627	1,467,180	0	5,003	37,413	64,368	0	101,781	718,703	2.1	7.1

3.5 ECO PROJECT SUMMARY

Table 3-30 on page 3-88 lists each ECO evaluated in the Interim Submittal, along with the ECO number designation. Table 3-31 beginning on page 3-89 lists all the ECOs evaluated, listed by ECO number. The table provides the predicted annual energy savings (type and amount), annual dollar savings, construction costs (including SIOH and design cost), and life cycle economics, including SIR and simple payback.

Table 3-32 beginning on page 3-91 provides the same list of ECO results, listed in order of descending SIR.

To qualify as an ECIP project, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than $300,000, an SIR greater than 1.0, and a simple payback less than eight years. Projects which normally do not meet ECIP criteria, but have an overall SIR greater than 1.0, are referenced as non-ECIP projects.

TABLE 3-30
ENERGY CONSERVATION OPPORTUNITIES LIST

ECO NUMBER	ECO DESCRIPTION
1	Insulate Walls, Roofs, Pipes, and Ducts
2	Insulate Windows
3	Weatherstripping and Caulking
4	Domestic Hot Water Temperature
5	Install High Efficiency Electric Motors
6	Economizers
7	Control Hot Water Circulation Pump
8	Install Low-flow Shower and Faucet Fixtures
9	Heat Reclaim from Hot Refrigerant Gas
10	Prevent Air Stratification
11	Replace Street Lights
12	Revise or Repair HVAC Controls
13	Thermal Storage
14	Radiant Heaters and Loading Dock Seals
15	Separate Light Switches
16	Investigate Post Demand Usage
17	Boiler Operation Schedule
18	Replace Exit Sign Bulbs with Fluorescent Bulb Kit
19	Previous Lighting Review Study

TABLE 3-31
ECONOMIC SUMMARY OF ECOs, LISTED BY ECO NUMBER

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND CREDIT ($)	NON-ENERGY SAVINGS ($)	TOTAL COST AVOID ($)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
1-Wall Insulation		NO BUILDINGS WITH SIR GREATER THAN 1.0									
1-Roof Insulation	4	3,164	51	62	318	406	0	724	3,791	3.4	5.2
1-Duct Insulation	0	29,656	243	345	1,893	0	0	1,893	9,625	4.0	5.1
1-Pipe Insulation	0	24	880	880	4,110	0	0	4,110	10,717	9.1	2.6
2-Insulate Windows		NO BUILDINGS WITH SIR GREATER THAN 1.0									
3-Caulking	2	22	1	1	5	234	0	240	1,485	2.4	6.2
4-HW Temp		NOT APPLICABLE - MEASUREMENT ONLY									
5-High Eff. Motor	54	264,518	0	902	6,745	5,594	0	12,339	162,986	1.1	13.2
6-Economizer		NO BUILDINGS WITH SIR GREATER THAN 1.0									
7-HW Pump Control	0	128,957	876	1,316	7,379	0	0	7,379	33,008	2.9	4.5
8-Shower/Faucet	0	0	1,001	1,001	4,674	0	6,495	11,169	10,956	12.4	1.0
9-Heat Reclaim		NO BUILDINGS WITH SIR GREATER THAN 1.0									
10-Air Stratification		NO BUILDINGS WITH SIR GREATER THAN 1.0									
11-Street Lights	0	43,362	0	148	1,111	0	417	1,527	6,917	3.4	4.5
12-HVAC Controls	93	1,380,662	1,386	6,094	41,678	9,505	1,143	52,327	273,301	2.2	5.2
13-Thermal Storage		NO BUILDINGS WITH SIR GREATER THAN 1.0									
14-Dock Seals		NOT APPLICABLE									
14-IR Heaters		NOT APPLICABLE									

TABLE 3-31
ECONOMIC SUMMARY OF ECOs, LISTED BY ECO NUMBER

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND CREDIT ($)	NON-ENERGY SAVINGS ($)	TOTAL COST AVOID ($)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
15-Light Control B200	163	761,510	0	2,599	19,419	16,734	0	36,152	142,464	3.8	3.9
15-Light Control	13	46,857	(25)	135	1,077	1,368	0	2,445	28,173	1.3	11.5
16-Demand	214	0	0	0	0	21,983	0	21,983	81,982	2.8	3.7
17-Boiler		NOT APPLICABLE									
18-Exit Signs	12	102,755	0	351	2,631	1,204	(1,181)	2,654	16,567	2.5	6.2
19-Lighting Retrofit	627	1,467,180	0	5,003	37,413	64,368	0	101,781	718,703	2.1	7.1

TABLE 3-32
ECONOMIC SUMMARY OF ECOs, LISTED BY SIR

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND CREDIT ($)	NON-ENERGY SAVINGS ($)	TOTAL COST AVOID ($)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
8-Shower/Faucet	0	0	1,001	1,001	4,674	0	6,495	11,169	10,956	12.4	1.0
1-Pipe Insulation	0	24	880	880	4,110	0	0	4,110	10,717	9.1	2.6
1-Duct Insulation	0	29,656	243	345	1,893	0	0	1,893	9,625	4.0	5.1
15-Light Control B200	163	761,510	0	2,599	19,419	16,734	0	36,152	142,464	3.8	3.9
1-Roof Insulation	4	3,164	51	62	318	406	0	724	3,791	3.4	5.2
11-Street Lights	0	43,362	0	148	1,111	0	417	1,527	6,917	3.4	4.5
7-HW Pump Control	0	128,957	876	1,316	7,379	0	0	7,379	33,008	2.9	4.5
16-Demand	214	0	0	0	0	21,983	0	21,983	81,982	2.8	3.7
18-Exit Signs	12	102,755	0	351	2,631	1,204	(1,181)	2,654	16,567	2.5	6.2
3-Caulking	2	22	1	1	5	234	0	240	1,485	2.4	6.2
12-HVAC Controls ,	93	1,380,662	1,386	6,094	41,678	9,505	1,143	52,327	273,301	2.2	5.2
19-Lighting Retrofit	627	1,467,180	0	5,003	37,413	64,368	0	101,781	718,703	2.1	7.1
15-Light Control	13	46,857	(25)	135	1,077	1,368	0	2,445	28,173	1.3	11.5
5-High Eff. Motor	54	264,518	0	902	6,745	5,594	0	12,339	162,986	1.1	13.2
TOTAL	**1,182**	**4,228,667**	**4,413**	**18,837**	**128,453**	**121,396**	**6,874**	**256,723**	**1,500,675**	**2.7**	**5.8**
4-HW Temp		NOT APPLICABLE - MEASUREMENT ONLY									
2-Insulate Windows		NO BUILDINGS WITH SIR GREATER THAN 1.0									

TABLE 3-32
ECONOMIC SUMMARY OF ECOs, LISTED BY SIR

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND CREDIT ($)	NON-ENERGY SAVINGS ($)	TOTAL COST AVOID ($)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
2-Insulate Windows		NO BUILDINGS WITH SIR GREATER THAN 1.0									
1-Wall Insulation		NO BUILDINGS WITH SIR GREATER THAN 1.0									
9-Heat Reclaim		NO BUILDINGS WITH SIR GREATER THAN 1.0									
6-Economizer		NO BUILDINGS WITH SIR GREATER THAN 1.0									
17-Boiler		NOT APPLICABLE									
14-IR Heaters		NOT APPLICABLE									
10-Air Stratification		NO BUILDINGS WITH SIR GREATER THAN 1.0									
14-Dock Seals		NOT APPLICABLE									
13-Thermal Storage		NO BUILDINGS WITH SIR GREATER THAN 1.0									

3.6 RESULTS

Of the individual ECOs evaluated, 11 projects had an SIR greater than 1.0 (see Table 3-32 on page 3-91). Those ECOs having an SIR greater than 1.0 are by definition economically feasible. The total savings and costs associated with these 11 projects are:

• Annual Electrical Savings (kWh):	4,228,667
• Annual Electrical Demand Savings (kW):	1,182
• Annual Natural Gas Savings (MBtu):	4,413
• Total Energy Savings (MBtu):	18,837
• Total First Year Annual Utility Cost Avoidance ($):	256,723
• Total Construction Cost ($):	1,500,675

All ECOs which were determined to have SIRs less than 1.0 should be dropped from further analysis. These include:

- ECO 1, Wall Insulation
- ECO 2, Insulated Windows
- ECO 6, Economizers
- ECO 9, Heat Reclaim from Hot Refrigerant Gas
- ECO 10, Prevent Air Stratification
- ECO 13, Thermal Storage

SECTION 4.0

ENERGY CONSERVATION PROJECTS

4.1 PROJECT DEVELOPMENT

The individual ECOs determined to be economically viable were reviewed at the Interim Submittal review conference with the Fort McPherson DEH and the Savannah District COE, and grouped into projects for possible funding under four main funding areas:

- Energy Conservation Investment Program (ECIP) projects
- Non-ECIP, including Quick Return on Investment Program (QRIP), Military Construction Army (MCA) program, and low-cost/no-cost projects
- Family Housing Projects, funded by housing program budgets
- Non-Appropriated Funds (NAF) Projects, funded by agencies and organizations maintaining clubs, commissary, exchange, and related buildings.

Subsequent to the Interim Submittal, the Fort McPherson DEH provided a list of buildings which have reimbursed utilities (NAF buildings), plus buildings which are to be torn down in the near future. Facilities to be torn down were eliminated from all possible projects. NAF buildings were eliminated from all projects, except those specifically categorized for NAF funding. Elimination of these facilities required the ECIP projects recommended in the Interim Submittal to be revised to take into account lower individual ECO construction cost estimates.

To qualify as an ECIP project, an ECO, or several combined ECOs, must have a construction cost estimate greater than $300,000, a savings-to-investment ratio (SIR) greater than 1.0, and a simple payback less than 8 years. The overall project, and each discrete part of the project, must have an SIR greater than 1.0. At Fort McPherson, one project was evaluated for ECIP funding:

- ECIP Project, including the following ECOs:

  - ECO 1, Add pipe insulation
  - ECO 1, Add roof insulation
  - ECO 1, Add duct insulation
  - ECO 7, Control hot water circulation pumps
  - ECO 11, Replace street lights
  - ECO 12, Revise or repair HVAC controls
  - ECO 15, Lighting controls in Building 200
  - ECO 18, Replace exit signs bulbs with fluorescent bulb kits
  - ECO 19, Previous lighting review study, for light fixture replacements.

Non-ECIP projects, funded under the QRIP program, must have a construction cost estimate less than $100,000 and a simple payback period of two years or less. Projects funded with MCA money must have a construction cost greater than $200,000 and a simple payback period of four to twenty-five years. At Fort McPherson, one project was evaluated for QRIP funding:

- QRIP Project - ECO 8, Install low-flow shower and faucet fixtures.

Projects which directly relate to family housing facilities should receive funding from housing program budgets. One project at Fort McPherson was evaluated for funding by housing program budgets:

- Housing Project - ECO 16, One-way FM radio control of air-conditioning condensing units.

ECOs evaluated for NAF facilities which have an SIR greater than 1.0 and a simple payback less than 8 years, were lumped together for consideration by NAF related organizations. These ECOs include:

- ECO-1, Add pipe insulation
- ECO-1, Add duct insulation
- ECO-7, Control hot water circulation pumps
- ECO-12, Revise or repair HVAC controls

Three energy projects evaluated for Fort McPherson did not qualify for ECIP funding, based on energy versus non-energy savings ratios, and total construction costs below the $200,000 limitation for MCA funding. Fort McPherson should consider funding these projects through other funding avenues, such as operations and maintenance budgets. These ECOs include:

- ECO-3, Weatherstripping and caulking
- ECO-5, Install high efficiency electric motors
- ECO-15, Separate (automatic) light switches.

The results of analysis for each project are contained in the following sections. The backup calculations for these projects are provided in Appendix D to this Volume I. See Section 3.0 for details related to the evaluation of individual ECOs.

Any reduction of total energy savings resulting from the simultaneous implementation of more than one ECO, if any, was not taken into consideration. It is estimated the reduction in savings is negligible.

4.2 ECIP PROJECTS

Premise:

This project proposes to install a combination of several ECOs on buildings and mechanical equipment to reduce utility costs. The ECOs include:

- ECO 1, Add pipe insulation
- ECO 1, Add roof insulation
- ECO 1, Add duct insulation
- ECO 7, Control hot water circulation pumps
- ECO 11, Replace street lights
- ECO 12, Revise or repair HVAC controls
- ECO 15, Lighting controls in Building 200
- ECO 18, Replace exit signs bulbs with fluorescent bulb kits
- ECO 19, Previous lighting review study, for light fixture replacements.

ECO 1 involves reducing energy consumption by adequately insulating pipes. Adequate insulation thickness is defined as the recommended thickness from Corps of Engineer guide specifications and ASHRAE Standard 90.1-1989. Buildings which require pipe insulation include Buildings 61, 111, and 112.

ECO 1 involves reducing energy consumption by adequately insulating roofs. In some cases, roofs had little or no insulation. For this project, R-19 fiberglass batt insulation is recommended to be installed in ceiling spaces. Only Building 168 requires roof insulation.

ECO 1 also involves reducing energy consumption by adequately insulating ductwork. Adequate insulation thickness is defined as the recommended thickness from Corps of Engineer guide specifications and ASHRAE Standard 90.1-1989. Buildings which require duct insulation include Buildings 42, 105, 358.

ECO 7 involves turning off HW and DHW circulation pumps when they are not needed. HW pumps run continuously during the heating season. HW pumps could be shut off using optimization controls during unoccupied periods and when heating loads are met in the building. This will result in heating and electric energy savings. DHW circulation pumps operate continuously year round. Installing time clocks on these pumps will minimize operating time. Buildings appropriate for providing hot water pump controls include Buildings 170 and 171.

ECO 11 involves replacing twelve 1500-watt exterior quartz lamp fixtures with 400-watt high pressure sodium lamp fixtures to save energy. Replacing quartz bulbs with higher efficiency HPS bulbs will also have non-energy labor savings, because quartz bulbs have a shorter life than HPS bulbs.

ECO 12 involves installation of direct digital controls (DDC) in place of existing local loop controls. Many of the existing local loop controls operate poorly, over-condition spaces, and

waste energy. New DDC would maintain proper temperature setpoints, reduce service calls for temperature-related problems, and reduce energy consumption. Buildings appropriate for providing DDC include Buildings 100, 101, 131, 170, 171, 181, 246, and 514.

ECO 15 involves installation of automatic lighting controls in Building 200 to reduce electrical usage. Currently lighting remains on in Building 200 past normal occupancy periods. Automatic lighting controls for open office and individual office areas could provide significant savings. Automatic lighting control for open office areas would use scheduled lighting control based on time-of-day, with override capability provided by dial-up telephone and manual switches. Automatic lighting control of individual offices would use occupancy sensor controls.

ECO 18 involves replacing incandescent exit sign light bulbs with fluorescent. This replacement will result in 272 kWh saved per year per fixture. Buildings appropriate for replacing exit sign bulbs include Buildings 41, 56, 58, 60, 62, 101, 170, 171, 181, 184, 200, 246, 363, 366, 400, and 401.

ECO 19 involves the replacement of office light fixtures with more efficient fluorescent fixtures having approximately the same or higher illuminance levels. The savings determined by a previous study indicate the energy savings will justify the replacement cost. See Feasibility Study for Lighting Shared Energy Savings Project, Ft. McPherson and Ft. Gillem, Georgia for buildings to be incorporated into the project.

Table 4-1 on page 4-5 provides an economic summary of the ECIP Project.

Results:

Annual Natural Gas Savings (MBtu)	1,818
Annual Electrical Energy Savings (kWh)	3,692,847
Annual Demand Savings (kW)	895
Annual Non-Energy Cost Savings	$252
Total Annual Cost Savings	$194,726
Estimated Construction Cost	$1,148,881
Analysis Period (years)	15
Simple Payback (years)	5.9
Savings-to-Investment Ratio (SIR)	1.9

Recommendation: Implement

TABLE 4-1
ECIP PROJECT SUMMARY

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND CREDIT ($)	NON-ENERGY SAVINGS ($)	TOTAL COST AVOID ($)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
ECO-1 Pipe	0	4	177	177	827	0	0	827	6,766	2.9	8.2
ECO-1 Roof	4	3,164	51	62	319	406	0	724	3,791	3.4	5.2
ECO-1 Duct	0	12,929	119	163	883	0	0	883	4,065	4.5	4.6
ECO-7	0	95,278	498	823	4,755	0	0	4,755	22,006	2.8	4.6
ECO-11	0	43,362	0.00	148	1,110	0	417	1,527	6,917	3.4	4.5
ECO-12	89	1,206,665	973	5,087	35,313	9,095	1,016	45,423	227,602	2.3	5.0
ECO-15 B200	163	761,510	0.00	2,599	19,419	16,734	0	36,152	142,464	3.8	3.9
ECO-18	12	102,755	0.00	351	2,631	1,204	(1,181)	2,654	16,567	2.5	6.2
ECO-19	627	1,467,180	0.00	5,003	37,413	64,368	0	101,781	718,703	2.1	7.1
TOTAL	895	3,692,847	1,818	14,413	102,669	91,807	252	194,726	1,148,881	1.9	5.9

4.3 NON-ECIP PROJECTS

4.3.1 QRIP PROJECT

Premise:

This project, made up of only ECO-8, proposes replacing shower heads and faucets with low-flow shower heads and faucets to minimize hot water consumption. Field measurements of existing showers indicate flows as high as 5.6 gallons per minute (gpm). This rate can be reduced to 1.5 gpm. Replacing shower heads and faucets can lower natural gas, water, and sewage charges. Buildings appropriate for replacing shower heads and faucets include Buildings 27, 28, 40, 56, 58, 60, 62, 109, 168, 363, and 401.

Results:

Annual Natural Gas Savings (MBtu)	1,001
Annual Electrical Energy Savings (kWh)	0
Annual Demand Savings (kW)	0
Annual Non-Energy Cost Savings	$6,495
Total Annual Cost Savings	$11,169
Estimated Construction Cost	$10,956
Analysis Period (years)	15
Simple Payback (years)	1.0
Savings-to-Investment Ratio (SIR)	12.4

Recommendation: Implement.

4.3.2 MCA PROJECT

No Non-ECIP projects were identified for funding under the MCA program.

4.3.3 LOW-COST/NO-COST PROJECT

No Non-ECIP projects were identified for funding under the low-cost/no-cost program.

4.4 FAMILY HOUSING PROJECT

Premise:

This project, made up of only ECO-16, involves installing a computer-based utility control system (UCS) using one-way FM radio transmission media to control family housing heat pump DX compressor units to lower post electric demand. The UCS would monitor instantaneous electric demand and predict demand, which would be used by the power company for billing purposes. If the UCS predicts the electrical demand will exceed a peak value limit (target), it would shed or cycle selected loads on a prescheduled priority basis, to reduce the connected load before the actual peak exceeds the target.

The system would include 108 FM radio-controlled switches mounted on family housing DX compressor units, a central PC based computer located at DEH, FM radio transmitter, antennas, and monitoring of the Georgia Power Company substation electric meter.

Results:

Annual Natural Gas Savings (MBtu)	0
Annual Electrical Energy Savings (kWh)	0
Annual Demand Savings (kW)	214
Annual Non-Energy Cost Savings	$0
Total Annual Cost Savings	$21,983
Estimated Construction Cost	$81,982
Analysis Period (years)	15
Simple Payback (years)	3.7
Savings-to-Investment Ratio (SIR)	2.8

Recommendation: Implement.

4.5 NAF PROJECTS

ECOs evaluated for NAF facilities which qualified under other funding programs, were grouped together for consideration by NAF related organizations. Buildings appropriate for NAF projects include Buildings 155, 360, and 500.

Table 4-2 on page 4-8 provides an economic summary of projects which should be funded by NAF facility organizations to lower utility consumptions. The summary indicates there are 3 ECOs with an SIR greater than 1.0 and a simple payback less than 8 years, for a total construction cost of $57,005. The combined results of the best 3 ECO projects are presented below.

Results:

Annual Natural Gas Savings (MBtu)	1,486
Annual Electrical Energy Savings (kWh)	207,680
Annual Demand Savings (kW)	4
Annual Non-Energy Cost Savings	$0
Total Annual Cost Savings	$12,645
Estimated Construction Cost	$60,369
Analysis Period (years)	15
Simple Payback (years)	4.8
Savings-to-Investment Ratio (SIR)	2.7

Recommendation: Implement the three ECOs listed.

TABLE 4-2
NAF ECONOMIC SUMMARY

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND CREDIT ($)	NON-ENERGY SAVINGS ($)	TOTAL COST AVOID ($)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
ECO-1	0	4	695	695	3,245	0	0	3,245	3,667	21.0	1.1
ECO-7	0	33,679	378	493	2,624	0	0	2,624	11,003	3.2	4.2
ECO-12	4	173,997	413	1,006	6,366	411	0	6,776	45,699	1.8	6.7
TOTAL	4	207,680	1,486	2,194	12,235	411	0	12,645	60,369	2.7	4.8

4.6 OTHER ENERGY PROJECTS

Three energy projects evaluated for Fort McPherson did not qualify for ECIP or Non-ECIP funding. Fort McPherson should consider funding these projects through other funding avenues, such as operations and maintenance budgets. These ECOs include:

- ECO-3, Weatherstripping and caulking
- ECO-5, Install high efficiency electric motors
- ECO-15, Separate (automatic) light switches

ECO 3 involves providing weatherstripping and caulking around doors and windows to reduce infiltration. In many cases, weatherstripping and caulking are in poor condition. Buildings which need weatherstripping and caulking. Building 155 is in need of weatherstripping and caulking.

ECO 5 involves replacing standard efficiency motors with high efficiency motors to save electrical energy and demand. Buildings appropriate for installing high efficiency motors include Buildings 56, 58, 60, 62, 101, 131, 168, 170, 181, 200, 206, 246, 360, 363, 400, 401, and 514.

ECO 15 involves installation of occupancy sensor lighting controls. Currently, interior lighting is left on, either because no local switching is available or because people do not turn the lights off when they leave their offices for short periods of time. Providing occupancy sensor light switches can save energy. Buildings appropriate for installing sensor lighting controls include Buildings 41, 101, 170, 171, 246, 366, and 401.

Table 4-3 on page 4-10 provides an economic summary of projects Fort McPherson should consider funding through alternate methods.

Results:

Annual Natural Gas Savings (MBtu)	(24)
Annual Electrical Energy Savings (kWh)	311,397
Annual Demand Savings (kW)	69
Annual Non-Energy Cost Savings	$0
Total Annual Cost Savings	$15,024
Estimated Construction Cost	$192,644
Analysis Period (years)	25
Simple Payback (years)	12.8
Savings-to-Investment Ratio (SIR)	1.2

TABLE 4-3
OTHER ENERGY PROJECTS SUMMARY

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND CREDIT ($)	NON-ENERGY SAVINGS ($)	TOTAL COST AVOID ($)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
ECO-3	2	22	1	1	5	234	0	240	1,485	2.4	6.2
ECO-5	54	264,518	0	902	6,745	5,594	0	12,339	162,986	1.1	13.2
ECO-15	13	46,857	(25)	135	1,077	1,368	0	2,445	28,173	1.3	11.5
TOTAL	69	311,397	(24)	1,039	7,828	7,196	0	15,024	192,644	1.2	12.8

SECTION 5.0

SUMMARY AND RECOMMENDATIONS

5.1 SUMMARY

5.1.1 ECOs EVALUATED

Seventeen ECOs were identified in the SOW to be evaluated for selected buildings at Fort McPherson. During the entrance interview conference, ECO 18 was included, to be evaluated for all buildings specified for ECO 15, lighting controls. ECO 18 involves replacing incandescent exit signs light bulbs with fluorescent bulbs. After discussions with DEH, it was also decided to include the results of previous lighting studies (see Section 1.6), which were originally evaluated as shared energy savings projects. The results were included as ECO 19; economics are based on design, bid, and construction, direct by the Government, rather than by an energy service contractor under a shared energy savings contract.

Subsequent to the field survey, each ECO for each building was reviewed to determine if it was technically feasible. ECOs which are not technically feasible were eliminated from further evaluation. In addition, as the facilities were surveyed, some ECOs included in the SOW were found to apply to buildings not identified in the ECO matrix (Annexes B and C). With the approval of DEH, these buildings were added to the original list.

5.1.2 RESULTS

Of the individual ECOs evaluated, 14 projects had an SIR greater than 1.0 (see Table 5-2 on page 5-4). Those ECOs having an SIR greater than 1.0 are by definition economically feasible. The total estimated construction cost for the 14 projects is $1,500,675.

Table 5-1 on page 5-2 lists the economic summary of each individual ECO, in ECO number order. Table 5-2 on page 5-4 lists the economic summary of each individual ECO, in order by SIR.

All ECOs having an SIR less than 1.0 were dropped from further analysis. These included:

- ECO 1, Wall Insulation
- ECO 2, Insulated Windows
- ECO 6, Economizers
- ECO 9, Heat Reclaim from Hot Refrigerant Gas
- ECO 10, Prevent Air Stratification
- ECO 13, Thermal Storage

TABLE 5-1
ECONOMIC SUMMARY OF ECOs, LISTED BY ECO NUMBER

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND CREDIT ($)	NON-ENERGY SAVINGS ($)	TOTAL COST AVOID ($)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
1-Wall Insulation		NO BUILDINGS WITH SIR GREATER THAN 1.0									
1-Roof Insulation	4	3,164	51	62	318	406	0	724	3,791	3.4	5.2
1-Duct Insulation	0	29,656	243	345	1,893	0	0	1,893	9,625	4.0	5.1
1-Pipe Insulation	0	24	880	880	4,110	0	0	4,110	10,717	9.1	2.6
2-Insulate Window		NO BUILDINGS WITH SIR GREATER THAN 1.0									
3-Caulking	2	22	1	1	5	234	0	240	1,485	2.4	6.2
4-HW Temp		NOT APPLICABLE - MEASUREMENT ONLY									
5-High Eff. Motor	54	264,518	0	902	6,745	5,594	0	12,339	162,986	1.1	13.2
6-Economizer		NO BUILDINGS WITH SIR GREATER THAN 1.0									
7-HW Pump Control	0	128,957	876	1,316	7,379	0	0	7,379	33,008	2.9	4.5
8-Shower/Faucet	0	0	1,001	1,001	4,674	0	6,495	11,169	10,956	12.4	1.0
9-Heat Reclaim		NO BUILDINGS WITH SIR GREATER THAN 1.0									
10-Air Stratification		NO BUILDINGS WITH SIR GREATER THAN 1.0									
11-Street Lights	0	43,362	0	148	1,111	0	417	1,527	6,917	3.4	4.5
12-HVAC Controls	93	1,380,662	1,386	6,094	41,678	9,505	1,143	52,327	273,301	2.2	5.2
13-Thermal Storage		NO BUILDINGS WITH SIR GREATER THAN 1.0									
14-Dock Seals		NOT APPLICABLE									
14-IR Heaters		NOT APPLICABLE									

TABLE 5-1
ECONOMIC SUMMARY OF ECOs, LISTED BY ECO NUMBER

(CONCLUDED)

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND CREDIT ($)	NON-ENERGY SAVINGS ($)	TOTAL COST AVOID ($)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
15-Light Control B200	163	761,510	0	2,599	19,419	16,734	0	36,152	142,464	3.8	3.9
15-Light Control	13	46,857	(25)	135	1,077	1,368	0	2,445	28,173	1.3	11.5
16-Demand	214	0	0	0	0	21,983	0	21,983	81,982	2.8	3.7
17-Boiler		NOT APPLICABLE									
18-Exit Sign	12	102,755	0	351	2,631	1,204	(1,181)	2,654	16,567	2.5	6.2
19-Lighting Retrofit	627	1,467,180	0	5,003	37,413	64,368	0	101,781	718,703	2.1	7.1

TABLE 5-2
ECONOMIC SUMMARY OF ECOs, LISTED BY SIR

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND CREDIT ($)	NON-ENERGY SAVINGS ($)	TOTAL COST AVOID ($)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
8-Shower/Faucet	0	0	1,001	1,001	4,674	0	6,495	11,169	10,956	12.4	1.0
1-Pipe Insulation	0	24	880	880	4,110	0	0	4,110	10,717	9.1	2.6
1-Duct Insulation	0	29,656	243	345	1,893	0	0	1,893	9,625	4.0	5.1
15-Light Control B200	163	761,510	0	2,599	19,419	16,734	0	36,152	142,464	3.8	3.9
1-Roof Insulation	4	3,164	51	62	318	406	0	724	3,791	3.4	5.2
11-Street Light	0	43,362	0	148	1,111	0	417	1,527	6,917	3.4	4.5
7-HW Pump Control	0	128,957	876	1,316	7,379	0	0	7,379	33,008	2.9	4.5
16-Demand	214	0	0	0	0	21,983	0	21,983	81,982	2.8	3.7
18-Exit Sign	12	102,755	0	351	2,631	1,204	(1,181)	2,654	16,567	2.5	6.2
3-Caulking	2	22	1	1	5	234	0	240	1,485	2.4	6.2
12-HVAC Controls	93	1,380,662	1,386	6,094	41,678	9,505	1,143	52,327	273,301	2.2	5.2
19-Lighting Retrofit	627	1,467,180	0	5,003	37,413	64,368	0	101,781	718,703	2.1	7.1
15-Light Control	13	46,857	(25)	135	1,077	1,368	0	2,445	28,173	1.3	11.5
5-High Eff. Motor	54	264,518	0	902	6,745	5,594	0	12,339	162,986	1.1	13.2
TOTAL	**1,182**	**4,228,667**	**4,413**	**18,837**	**128,453**	**121,396**	**6,847**	**256,723**	**1,500,675**	**2.7**	**5.8**
4-HW Temp		NOT APPLICABLE - MEASUREMENT ONLY									
2-Insulate Window		NO BUILDINGS WITH SIR GREATER THAN 1.0									

TABLE 5-2
ECONOMIC SUMMARY OF ECOs, LISTED BY SIR

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND CREDIT ($)	NON-ENERGY SAVINGS ($)	TOTAL COST AVOID ($)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
1-Wall Insulation		NO BUILDINGS WITH SIR GREATER THAN 1.0									
9-Heat Reclaim		NO BUILDINGS WITH SIR GREATER THAN 1.0									
6-Economizer		NO BUILDINGS WITH SIR GREATER THAN 1.0									
17-Boiler		NOT APPLICABLE									
14-IR Heaters		NOT APPLICABLE									
10-Air Stratification		NO BUILDINGS WITH SIR GREATER THAN 1.0									
14-Dock Seals		NOT APPLICABLE									
13-Thermal Storage		NO BUILDINGS WITH SIR GREATER THAN 1.0									

5.1.3 ENERGY PROJECT DEVELOPMENT

Individual ECOs were grouped into projects for possible funding under four main funding areas:

- Energy Conservation Investment Program (ECIP) projects

- Non-ECIP, including Quick Return on Investment Program (QRIP), Military Construction Army (MCA) program, and low-cost/no-cost projects

- Family Housing Projects, funded by housing program budgets

- Non-Appropriated Funds (NAF) Projects, funded by agencies and organizations maintaining clubs, commissary, exchange, and related buildings.

Following the Interim Submittal, Fort McPherson DEH provided a list of buildings which have reimbursed utilities (NAF buildings), plus buildings which are to be torn down in the near future. These facilities were eliminated from the ECIP funded projects. Elimination of these facilities required the ECIP projects recommended in the Interim Submittal to be revised to take into account lower individual ECO construction cost estimates.

At Fort McPherson, one project was evaluated for ECIP funding:

- ECIP Project, including the following ECOs:

  - ECO 1, Add pipe insulation
  - ECO 1, Add roof insulation
  - ECO 1, Add duct insulation
  - ECO 7, Control hot water circulation pumps
  - ECO 11, Replace street lights
  - ECO 12, Revise or repair HVAC controls
  - ECO 15, Lighting controls in Building 200
  - ECO 18, Replace exit signs bulbs with fluorescent bulb kits
  - ECO 19, Previous lighting review study, for light fixture replacements.

One project was evaluated for QRIP funding:

- QRIP Project - ECO 8, Install low-flow shower and faucet fixtures.

One project at Fort McPherson was evaluated for funding by housing program budgets:

- Housing Project - ECO 16, One-way FM radio control of air-conditioning condensing units.

ECOs evaluated for NAF facilities which have an SIR greater than 1.0 and a simple payback less than 8 years, were lumped together for consideration by NAF related organizations.

Three energy projects evaluated for Fort McPherson did not qualify for ECIP funding, based on energy versus non-energy savings ratios, and total construction costs below the $200,000 limitation for MCA funding. Fort McPherson should consider funding these projects through other funding avenues, such as operations and maintenance budgets. These ECOs include:

- ECO-3, Weatherstripping and caulking
- ECO-5, Install high efficiency electric motors
- ECO-15, Separate (automatic) light switches.

Table 5-3 on page 5-8 provides an economic summary of projects which should be considered for funding. Overall, there are $1,148,881 of potential ECIP projects, $92,938 of Non-ECIP projects, $60,369 of potential NAF projects, and $192,644 of other energy projects to fund.

TABLE 5-3
PROJECTS ECONOMIC SUMMARY

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND CREDIT ($)	NON-ENERGY SAVINGS ($)	TOTAL COST AVOID ($)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
ECIP	895	3,692,847	1,818	14,413	102,669	91,807	252	194,726	1,148,881	1.9	5.9
QRIP	0	0	1,001	1,001	4,675	0	6,495	11,170	10,956	12.4	1.0
FAMILY HOUSING	214	0	0	0	0	21,983	0	21,983	81,982	2.8	3.7
OTHER ENERGY PROJECT	69	311,397	(24)	1,039	7,828	7,196	0	15,024	192,644	1.2	12.8
NAF ECO-1	0	4	695	695	3,245	0	0	3,245	3,667	21.0	1.1
NAF ECO-7	0	33,679	378	493	2,624	0	0	2,624	11,003	3.2	4.2
NAF ECO-12	4	173,997	413	1,006	6,366	411	0	6,776	45,699	1.8	6.7
TOTAL	**1,182**	**4,211,924**	**4,281**	**18,647**	**127,407**	**121,397**	**6,747**	**255,548**	**1,494,832**		

5.2 RECOMMENDATIONS

- It is recommended the Army fund the construction of the ECIP Project to lower facility utility consumption in order to meet energy reduction goals of the Department of Defense.

- It is recommended the Army fund construction of the QRIP Project and Housing Project to lower facility utility consumption in order to meet energy reduction goals of the Department of Defense.

- It is recommended the results of the energy evaluations on NAF buildings be provided to the related organizations for possible funding.

APPENDIX A

SCOPE OF WORK AND CONFIRMATION NOTICES

18 June 1991

SCOPE OF WORK
FOR AN
ENERGY SAVINGS OPPORTUNITY SURVEY
ENERGY ENGINEERING ANALYSIS PROGRAM

TABLE OF CONTENTS

1. <u>BRIEF DESCRIPTION OF WORK</u>: The Architect-Engineer (AE) shall:

1.1 Perform a limited site survey of selected buildings or areas to insure that any methods of energy conservation which are practical and have not been evaluated in any previous energy study have been considered and the results documented.

1.2 Evaluate selected ECOs to determine their energy savings potential and economic feasibility.

1.3 Group recommended ECOs into projects for implementation as detailed herein.

1.4 Prepare a comprehensive report to document the work performed, the results and the recommendations.

2. <u>GENERAL</u>:

2.1 Other studies performed under the EEAP have been performed at this installation. Criteria for both the study and the resulting documentation has changed since the previous study was completed. This study is intended to consider specific ECOs in buildings and areas that may have been overlooked previously or recently identified.

2.2 The information and analysis outlined herein are considered to be minimum essentials for adequate performance of this study.

2.3 The AE shall ensure that all methods of energy conservation which will reduce the energy consumption of the installation in compliance with the Energy Resources Management Plan including those listed in Annex A have been considered and documented. All methods of energy conservation which are reasonable and practicable shall be considered, including improvements of operational methods and procedures as well as the physical facilities. All energy conservation opportunities which produce energy or dollar savings shall be documented in this report. Any energy conservation opportunity considered infeasible shall also be documented in the report with reasons for elimination. A list of general energy conservation opportunities to be used when evaluating specific buildings or areas is included as Annex A to this scope. This list shall be considered and the evaluation of each ECO documented in the report. This list is not intended to be restrictive but only to assure that basic and generally repetitive opportunities are addressed in the report. Some of the energy conservation opportunities may not be applicable to the specific building or area at these installations. A statement to that effect is all that is required.

2.4 The study shall include the energy consuming buildings or areas listed in Annex B and Annex C. Annex B contains a building/eco check list specifically for Ft. Gillem, GA and Annex C contains a building/eco check list specifically for Ft. McPherson, GA. The work in the areas may be reduced somewhat by building repetition.

2.5 The study shall consider the use of all energy sources. The energy sources may include electricity, natural gas, liquefied petroleum gas, bulk oil, other oil products, steam when

procured, gasoline, coal, solar, etc.

2.6 The "Energy Conservation Investment Program (ECIP) Guidance", described in letter from CEHSC-FU, dated 25 April 1988, and the latest revision from CEHSC-FU-P, establishes criteria for ECIP projects and shall be used for performing the economic analyses of all ECOs and projects.

2.7 Energy conservation opportunities determined to be technically and economically feasible shall be developed into projects acceptable to installation personnel. This may involve combining similar ECOs into larger packages which will qualify for ECIP or MCA funding, and determining, in coordination with installation personnel, the appropriate packaging and implementation approach for all feasible ECOs.

2.7.1 Projects which qualify for ECIP funding shall be identified, separately listed, and prioritized by the Savings to Investment Ratio (SIR).

2.7.2 All feasible non-ECIP projects shall be ranked in order of highest to lowest SIR.

3. PROJECT MANAGEMENT:

3.1 Project Managers. The AE shall designate a project manager to serve as a point of contact and liaison for work required under this contract. Upon award of this contract, the individual shall be immediately designated in writing. The AE's designated project manager shall be approved by the Contracting Officer prior to commencement of work. This designated individual shall be responsible for coordination of work required under this contract. The Contracting Officer will designate a project manager to serve as the Government's point of contact and liaison for all work required under this contract. This individual will be the Government's representative.

3.2 Installation Assistance. The Commanding Officer at each installation will designate an individual who will serve as the point of contact for obtaining information and assisting in establishing contacts with the proper individuals and organizations as necessary to accomplish the work required under this contract. This individual will be the installation representative.

3.3 Public Disclosures. The AE shall make no public announcements or disclosures relative to information contained or developed in this contract, except as authorized by the Contracting Officer.

3.4 Meetings. Meetings will be scheduled whenever requested by the AE or the Contracting Officer for the resolution of questions or problems encountered in the performance of the work. The AE and/or the designated representative(s) shall be required to attend and participate in all meetings pertinent to the work required under this contract as directed by the Contracting Officer. These meetings, if necessary, are in addition to the presentation and review conference.

3.5 Site Visits, Inspections, and Investigations. The AE shall visit and inspect/investigate the site of the project as necessary and required during the preparation and

accomplishment of the work. The AE shall coordinate with the installation point of contact on any requirements for access to secure areas.

3.6 Records.

3.6.1 The AE shall provide a record of all significant conferences, meetings, discussions, verbal directions, telephone conversations, etc., with Government representative(s) relative to this contract in which the AE and/or designated representative(s) thereof participated. These records shall be dated and shall identify the contract number, and modification number if applicable, participating personnel, subject discussed, and conclusions reached. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the records.

3.6.2 The AE shall provide a record of requests for and/or receipt of Government-furnished material, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of the work under this contract. The records shall be dated and shall identify the contract number and modification number, if applicable. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the record of request or receipt of material.

3.7 Interviews. The AE and the Government's representative shall conduct entry and exit interviews with the Director of Engineering and Housing before starting work at the installation and after completion of the field work. The Government's representative shall schedule the interviews at least one week in advance.

3.7.1 Entry. The entry interview shall thoroughly describe the intended procedures for the survey and shall be conducted prior to commencing work at the facility. As a minimum, the interview shall cover the following points:

a. Schedules.

b. Names of energy analysts who will be conducting the site survey.

c. Proposed working hours.

d. Support requirements from the Director of Engineering and Housing.

3.7.2 Exit. The exit interview shall include a thorough briefing describing the items surveyed and probable areas of energy conservation. The interview shall also solicit input and advice from the Director of Engineering and Housing.

4. SERVICES AND MATERIALS: All services, materials (except those specifically enumerated to be furnished by the Government), plant, labor, superintendence and travel necessary to perform the work and render the data required under this contract are included in the lump sum price of the contract.

5. PROJECT DOCUMENTATION: All energy conservation opportunities which the AE has

considered shall be included in one of the following categories and presented in the report as such:

5.1 ECIP Projects. To qualify as an ECIP project, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than $200,000, a Savings to Investment Ratio greater than one and a simple payback period of less than four years. For ECAM and family housing projects, the $200,000 limitation may not apply; and in such cases, the AE shall check with the installation for guidance. The overall project and each discrete part of the project shall have a SIR greater than one. For all projects meeting the above criteria, shall be arranged as specified in paragraph 2.8.1 and provided with the following documentation: life cycle cost analysis summary sheet(s), description of the work to be accomplished, backup data for the LCCA, ie, energy savings calculations and cost estimate(s), and the simple payback period. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs.

5.2 Non-ECIP Projects. Projects which normally do not meet ECIP criteria, but which have an overall SIR greater than one shall be documented. The life cycle cost analysis summary sheet shall be completed through and including line 7 for all projects or ECOs. Each shall be analyzed to determine if they are feasible even if they do not meet ECIP criteria. These ECOs or projects may not meet the nonenergy qualification test. For projects or ECOs in this category, the life cycle cost analysis summary sheet, completely filled out, with all the necessary backup data to verify the numbers presented, a complete description of the project, and the simple payback period shall be included in the report. Additionally, these projects shall be grouped in accordance with the requirements of the Government's representative, for one of the following categories:

a. Quick Return on Investment Program (QRIP). This program is for projects which have a total cost not over $100,000 and a simple payback period of two years of less.

b. OSD Productivity Investment Funding (OSD PIF). This program is for projects which have a total cost of more than $100,000 and a simple payback period of four years or less.

c. Productivity Enhancing Capital Investment Program (PECIP). This program is for projects which have a total cost of more than $3,000 and a simple payback period of four years or less.

The above programs are all described in detail in AR 5-4, Change No. 1.

d. Regular Military Construction Army (MCA) Program. This program is for projects which have a total cost greater than $200,000 and a simple payback period of four to twenty-five years.

e. Low Cost/No Cost Projects. These are projects which the Director of Engineering and Housing can perform using his resources.

5.3 Nonfeasible ECOs. All ECOs which the AE has considered but which are not feasible, shall be documented in the report with reasons and justifications showing why they

were rejected.

6. DETAILED SCOPE OF WORK: The general Scope of Work is intended to apply to contract efforts for all Army installations included under this contract except as modified by the detailed Scope of Work for each individual installation. The detailed Scope of Work is contained in Annexes B and C.

7. WORK TO BE ACCOMPLISHED:

7.1 Evaluate Selected ECOs. The AE shall analyze the ECOs listed in Annex A . These ECOs shall be analyzed in detail to determine their feasibility. Savings to Investment Ratios (SIRs) shall be determined using current ECIP guidance. The necessary data required for these projects may not be available, requiring the AE to visit the installation to obtain any necessary information. The AE shall provide all data and calculations needed to support the recommended ECO. All assumptions shall be clearly stated. Calculations shall be prepared showing how all numbers in the ECO were figured. Calculations shall be an orderly step-by-step progression from the first assumption to the final number. Descriptions of the products, manufacturers catalog cuts, pertinent drawings and sketches shall also be included. A life cycle cost analysis summary sheet shall be prepared for each ECO and included as part of the supporting data. For ECOs which would significantly affect the existing heating, ventilating, and air conditioning (HVAC) system (such as adding economizer cycles, repairing or revising HVAC controls, and thermal storage) the AE is required to run a computer simulation to analyze the system and to determine the energy savings. The computer program shall use established weather data files and may perform calculations on a true hour-by-hour basis or may condense weather files and the number of calculations in to several "typical" days per month. The AE shall submit a sample computer run with an explanation of all input and output data and a summary of program methodology and energy evaluation capabilities for approval by the Contracting Officer prior to use of the program for analysis. The A-E shall use the latest version of the Life Cycle Cost in Design (LCCID) computer program. This program is available from the BLAST Support Office located at the University of Illinois. The BLAST Support Office can be reached at 1-800-UIBLAST.

7.2 Perform a Limited Site Survey. The AE shall conduct a limited site survey to evaluate the ECOs in the buildings or areas listed in Annex B and Annex C. These lists are not intended to be restrictive but only to assure that these opportunities, as a minimum, are considered, discussed and documented in the report. The AE may be aware of other ECOs not included in Annex B and Annex C that will produce energy, manpower or dollar savings. These should be evaluated the same as the other ECOs. Each of the items shall be considered and discussed in the report. Those items on the list which are not practical, have been previously accomplished, are inappropriate or can be eliminated from detailed analysis based on preliminary analysis shall be listed in the report along with the reason for elimination from further analysis. All potential ECOs which are not eliminated by preliminary considerations shall be thoroughly documented and evaluated as to technical and economic feasibility. The AE shall obtain all the necessary data to evaluate the ECOs by conducting a site survey. However, the AE is encouraged to use any data that may have been documented in a previous study. The AE shall document his site survey on forms developed for the survey, or standard forms, and submit these completed forms at part of the report. All test and/or measurement equipment shall be

properly calibrated prior to its use.

7.3 Combine ECOs Into Recommended Projects. During the Interim Review Conference, as outlined in paragraph 7.4.1, the AE will be advised of the DEH's preferred packaging of recommended ECOs into projects for implementation. Some projects may be a combination of several ECOs, and others may contain only one. These projects will be evaluated and arranged as outlined in paragraph 5.1 and 5.2. Energy savings calculations shall take into account the synergistic effects of multiple ECOs within a project and the effects of one project upon another. The results of this effort will be reported in the Prefinal Submittal per paragraph 7.4.2.

7.4 Submittals, Presentations, and Reviews. The work accomplished shall be fully documented by a comprehensive report. The report shall be prepared using Wordperfect. The report shall have a table of contents and be indexed. Tabs and dividers shall clearly and distinctly divide sections, sub-sections, and appendices. All pages shall be numbered. The AE shall give a formal presentation of all but the final submittal to installation, command, and other Government personnel. The AE shall prepare slides or view graphs showing the results of the study to date for his presentation. During the presentation, the personnel in attendance shall be given ample opportunity to ask questions and discuss any changes deemed necessary to the study. A review conference will be conducted the same day, following the presentation. Each comment presented at the review conference will be discussed and resolved or action items assigned. The AE shall provide the comments from all reviewers and written notification of the action taken on each comment to all reviewing agencies within three weeks after the review meeting. It is anticipated that each presentation and review conference will require approximately one working day. The presentation and review conference will be at the installation on the date(s) agreeable to the Director of Engineering and Housing, the AE and the Government's representative. The Contracting Officer may require a resubmittal of any document(s), if such document(s) are not approved because they are determined by the Contracting Officer to be inadequate for the intended purpose. All formal presentations and review meetings will be held at Fort Mcpherson.

7.4.1 Interim Submittal. An interim report shall be submitted for review after the field survey has been completed and an analysis has been performed on all of the ECOs. The report shall indicate the work which has been accomplished to date, illustrate the methods and justifications of the approaches taken and contain a plan of the work remaining to complete the study. Calculations showing energy and dollar savings and SIRs of all the ECOs shall be included. The simple payback period of all ECOs shall be calculated and shown in the report. The AE shall submit the Scope of Work and any modifications to the Scope of Work as an appendix to the report. A narrative summary describing work and results to date shall be a part of this submittal. During the review period, the Government's representative shall coordinate with the Director of Engineering and Housing and provide the AE with direction for packaging or combining ECOs for programming purposes. The survey forms completed during this audit shall be submitted with this report. The survey forms only may be submitted in final form with this submittal. They should be clearly marked at the time of submission that they are to be retained. They shall be bound in a standard three-ring binder which will allow repeated disassembly and reassembly of the material contained within. A complete and separately bound report shall be prepared for each installation.

7.4.2 Prefinal Submittal. The AE shall prepare and submit the prefinal report when all work under this contract is complete. The AE shall submit the Scope of Work for the installation studied and any modifications to the Scope of Work as an appendix to the submittal. The report shall contain a narrative summary of conclusions and recommendations, together with all raw and supporting data, methods used, and sources of information. The report shall integrate all aspects of the study. The report shall include an order of priority by SIR in which the recommended ECOs should be accomplished. The synergistic effects of any related ECOs shall have been determined and their savings calculations adjusted accordingly. The prefinal report, separately bound Executive Summary and all appendices shall be bound in standard three-ring binders which will allow repeated disassembly and reassembly. The prefinal submittal shall be arranged to include (a) a separately bound Executive Summary to give a brief overview of what was accomplished and the results of this study (see Annex D) , (b) the narrative report containing a copy of the Executive Summary at the beginning of the volume and describing in detail what was accomplished and the results of this study, (c) documentation for the recommended projects, and (d) appendices to include the detailed calculations and all backup material. A list of all projects and ECOs developed during this study shall be included in the Executive Summary and shall include the following data from the life cycle cost analysis summary sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date. The prefinal report shall also include copies of all correspondence and meeting minutes.

7.4.3 Final Submittal. Any revisions or corrections resulting from comments made during the review of the prefinal report or during the presentation and review conference shall be incorporated into the final report. These revisions or corrections may be in the form of replacement pages, which may be inserted in the prefinal report, or complete new volumes. Pen and ink changes or errata sheets will not be acceptable. If replacement pages are to be issued, it shall be clearly stated with the prefinal submittal that the submitted documents will be changed only to comply with the comments made during the prefinal conference and that the volumes issued at the time of the prefinal submittal should be retained. Failure to do so will require resubmission of complete volumes. If new volumes are submitted, they shall be in standard three-ring binders and shall contain all the information presented in the prefinal report with any necessary changes made. Detailed instructions of what to do with the replacement pages should be securely attached to the replacement pages. An electronic copy of the final report shall be given to Savannah District. A hard copy of any original material or graphics that is not in diskette form shall also be given to Savannah District.

ANNEX A
ENERGY CONSERVATION OPPORTUNITIES

1. Insulation (wall, roof, pipe, duct, etc) The AE shall be provided with an asbestos survey which will identify asbestos insulation
2. Insulated glass or double glazed windows
3. Weatherstripping & caulking
4. Measure and record the water temperature of hot water heaters *
5. Electric motors - Check the adequacy of the size and efficiency of HVAC equipment with motors 10 hp or greater and provide recommendations. *
6. Add economizer cycles (dry bulb) and evaluate minimum outside air levels
7. Control hot water circulation pump (consider OA reset and optimization controls)
8. Install shower flow restrictors and faucet flow resistors
9. Heat reclaim from hot refrigerant gas
10. Prevent air stratification
11. Reduce street lights (evaluate existing survey and provide recommendation)
12. Revise or repair HVAC controls **
13. Thermal storage
14. Air curtains, loading dock seals, and infrared heaters
15. Separate switches to control lighting arrangements (consider automatic controls)
16. Investigate post demand usage. (Provide recommendation on ways to reduce the peak)
17. Evaluate boiler operation. Compare continuous 24 hour operation versus the current 16 hour per day .

* Investigate for all buildings that are surveyed.
** If replacement of HVAC controls for large air handling unit systems is recommended, the controls shall be revised in accordance with COE standard control panel design.

The matrices in Annex B and Annex C further delineate which ECOs are applicable to each building.

ANNEX B
DETAILED SCOPE OF WORK
ENERGY SAVINGS OPPORTUNITY SURVEY - FT. GILLEM, GA

1. General: The detailed scope of work provided here-in-after describes site specific requirements for an "Energy Savings Opportunity Survey" at Ft. Gillem, Georgia.

2. Scope: The Project Manager for this study shall provide all necessary work to complete the detailed energy audit as defined by the General Scope of Work and described in this and other attached annexes.

3. Detailed Requirements: All detailed requirements selected at Ft. Gillem for the purposes of this study shall specifically include the facilities and ECOs identified by the DEH as shown in this annex.

3.1 In paragraph 3.7 "Interviews" - interviews are to be scheduled at least (2) two weeks in advance by the A-E.

3.2 The installation reserves the right to substitute other like buildings for those designated to be surveyed.

3.3 The Fort Gillem point of contact (POC) is Mrs. Terry Seabrook (404) 752-3076/3807.

3.4 The A-E is to provide a cost estimate for each low cost/no cost project to reflect the cost of "contracting out".

3.5 For this study M (as in MBTU) is 10^6.

3.6 Provide a glossary and a table of contents in all volumes.

3.7 The A-E is responsible for furnishing the labor, materials, and equipment required for making all the necessary prints of the building plans. The DEH will furnish space and electricity for the AE's reproduction equipment . The AE shall coordinate the hours of operation with the installation point of contact.

3.8 In paragraph 7.1 "Evaluate selected ECOs" - The A-E is required to run a computer simulation to analyze those ECOs which involve adding economizer cycles, repairing HVAC controls, and thermal storage.

4. The Project Manager, for this study, shall make direct distribution of all required submittals and documentation in the numbers of copies as required. Submittals shall be sent to each agency as provided in the list shown in Annex G.

5. Reference Documents: The Project Manager for this study shall be given all the reference

information and data as mentioned throughout the Scope of Work. The data will be provided upon request from the Project Manager to the DEH. The reference material shown in Annex F shall be furnished upon request from the Project Manager for this study to Savannah District Project Manager.

<u>ECO/BUILDING CHECK LIST</u>

<u>ENERGY SAVINGS OPPORTUNITY SURVEY - FT. GILLEM, GA</u>

BUILDING	ECO NUMBER																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
*101 (ADMIN)	X	X	X	X	X	X	X		X			X			X		
102 (MAINT)				X	X					X							
103 (FIRE STA				X	X										X		
133 (O CLUB)				X	X				X								
207 (STOR)				X	X					X				X	X		
213 (CID BLDG				X	X										X		
214 (COMMISS)				X	X					X				X			
308 (STOR)				X	X												
400 (DOL)				X	X					X				X	X		
401 (81st ARC				X	X					X				X	X		
403T (DIN FAC				X	X												X
*505 (STOR)**				X	X												X
506 (STOR)																	X
507 (STOR)																	X
508 (STOR)																	X
509 (STOR)																	X
510 (STOR)																	X
511 (STOR)																	X
512 (STOR)	X	X	X	X	X					X				X	X		
513 (STOR)																	X
514 (STOR)																	X
701T (ADMIN)	X	X	X												X		X
702T (ADMIN)	X	X	X												X		X
703T (ADMIN)	X	X	X												X		X
704T (ADMIN)	X	X	X	X	X										X		X

ECO 27 is postwide.
T Denotes that the building is temporary construction.
* This building is secure or has secure areas that will require an escort.
** Bldg 505 is typical for all the 500 block building (except 512). Only survey this typical building.

ECO/BUILDING CHECK LIST
ENERGY SAVINGS OPPORTUNITY SURVEY - FT. GILLEM, GA

BUILDING	ECO NUMBER																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
705T ADMIN***	X	X	X												X		X
706T (ADMIN)	X	X	X												X		X
707T (ADMIN)	X	X	X												X		X
708T (ADMIN)	X	X	X												X		X
709T (ADMIN)	X	X	X												X		X
710T (ADMIN)	X	X	X												X		X
735T (CHAPEL)	X	X	X	X	X												
918T (BOWLING				X	X										X		
922 (ADMIN)	X	X	X	X	X										X		
923 (STOR)	X	X	X	X	X										X		
935 (FIT CTR)				X	X										X		
942T (DIN FAC				X	X	X	X		X								

ECO 27 is postwide.
T Denotes that the building is temporary construction.
*** Bldg 705 is typical for buildings 701 thru 710. Only survey this typical building.

ANNEX C
DETAILED SCOPE OF WORK
ENERGY SAVINGS OPPORTUNITY SURVEY - FT.MCPHERSON, GA

1. General: The detailed scope of work provided here-in-after describes site specific requirements for an "Energy Savings Opportunity Survey" at Ft. McPherson, Georgia.

2. Scope: The Project Manager for this study shall provide all necessary work to complete the detailed energy audit as defined by the General Scope of Work and described in this and other attached annexes.

3. Detailed Requirements: All detailed requirements selected at Ft. McPherson for the purposes of this study shall specifically include the facilities and ECOs identified by the DEH as shown in this annex.

3.1 In paragraph 3.7 "Interviews" - interviews are to be scheduled at least (2) two weeks in advance by the A-E.

3.2 The installation reserves the right to substitute other like buildings for those designated to be surveyed.

3.3 The Fort McPherson point of contact (POC) is Mrs. Terry Seabrook (404) 752-3076/3807.

3.4 The A-E is to provide a cost estimate for each low cost/no cost project to reflect the cost of "contracting out".

3.5 For this study M (as in MBTU) is 10^6.

3.6 Provide a glossary and a table of contents in all volumes.

3.7 The A-E is responsible for furnishing the labor, materials, and equipment required for making all the necessary prints of the building plans. The DEH will furnish space and electricity for the AE's reproduction equipment . The AE shall coordinate the hours of operation with the installation point of contact.

3.8 In paragraph 7.1 "Evaluate selected ECOs" - The A-E is required to run a computer simulation to analyze those ECOs which involve adding economizer cycles, repairing HVAC controls, and thermal storage.

4. The Project Manager, for this study, shall make direct distribution of all required submittals and documentation in the numbers of copies as required. Submittals shall be sent to each agency as provided in the list shown in Annex G.

5. Reference Documents: The Project Engineer for this study shall be given all the reference

information and data as mentioned throughout the Scope of Work. The data will be provided upon request from the Project Manager to the DEH. The reference material shown in Annex F shall be furnished upon request from the Project Manager for this study, to Savannah District Project Manager.

ECO/BUILDING CHECK LIST
ENERGY SAVINGS OPPORTUNITY SURVEY - FT. MCPHERSON, GA

BUILDING	ECO NUMBER																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
022 (ADMIN)	X	X	X	X	X			X				X					
027 (GUEST)	X	X	X	X	X			X									
028 (GUEST)	X	X	X	X	X			X									
040 (UPH)	X	X	X	X	X			X									
041 (ADMIN)	X	X	X	X	X										X		
042 (CHAPEL)	X	X	X	X	X												
056 (UPH)				X	X			X				X			X		
058 (UPH)				X	X			X				X			X		
060 (UPH)				X	X			X				X			X		
061 (LAB)	X	X	X	X	X												
062 (UPH)				X	X			X				X			X		
100 (DENTAL)	X	X	X	X	X												
101 (DENTAL)	X	X	X	X	X							X			X		
102 (POLICE)	X	X	X	X	X												
105 (LAB)	X	X	X	X	X												
109T (GUEST)	X	X	X	X	X			X									
111 (ADMIN)	X	X	X	X	X												
112 (ADMIN)	X	X	X	X	X												
114 (ADMIN)	X	X	X	X	X												
116 (ADMIN)	X	X	X	X	X												
117 (CLASS RM	X	X	X	X	X												
118 (ADMIN)	X	X	X	X	X												
120 (ADMIN)	X	X	X	X	X												
121 (ADMIN)	X	X	X	X	X												
122 (ADMIN)	X	X	X	X	X												

ECO 27 is postwide.
T Denotes that the building is temporary construction.

ECO/BUILDING CHECK LIST
ENERGY SAVINGS OPPORTUNITY SURVEY - FT. MCPHERSON, GA

BUILDING	ECO NUMBER																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
124 (ADMIN)	X	X	X	X	X												
126 (ADMIN)	X	X	X	X	X												
131 (CLINIC)				X	X	X											
155 (NCO CLUB	X	X	X	X	X												
168 (ADMIN)				X	X			X				X					
170 (CLINIC)				X	X	X	X		X						X		
171 (CLINIC)				X	X	X	X		X						X		
178 (TRAINING	X	X	X	X	X												
179 (CLASS RM	X	X	X	X	X												
181 (ADMIN)	X	X	X	X	X				X			X			X		
184 (STOR)	X	X	X	X	X	X	X								X		
187 (PX MAINT				X	X								X				
*200 (ADMIN)				X	X				X				X				
206 (ADMIN)				X	X		X										
246 (ADMIN)				X	X	X						X	X		X		
250 (LIBRARY)				X	X							X					
358T (ADMIN)	X	X	X	X	X	X						X					
360 (LAB)				X	X				X					X			
*363 (MAINT)				X	X										X		
366 (STOR)				X	X					X				X	X		
400 (MOR SPT)	X	X	X	X	X										X		
401 (BOWLING)				X	X										X		
500 (DIN FAC)				X	X	X	X		X			X					
514 (DAY CARE				X	X	X											
522 (GUEST)	X	X	X	X	X				X								

ECO 27 is postwide.
T Denotes that the building is temporary construction.
* This building is secure or has secure areas that will require an escort.

ANNEX D
EXECUTIVE SUMMARY GUIDELINE

1. Introduction

2. Building Data (types, number of similar buildings, sizes, etc.)

3. Present Energy Consumption.

   - o Total Annual Energy Used.
   - o Source Energy Consumption.
     - Electricity - KWH, Dollars, BTU
     - Fuel Oil - GALS, Dollars, BTU
     - Natural Gas - THERMS, Dollars, BTU
     - Propane - GALS, Dollars, BTU
     - Other - QTY, DOllars, BTU

   o Energy Consumption of the buildings in this study as compared to the basewide consumption.

4. Historical Energy Consumption.

5. Energy Conservation Analysis.

   - o ECOs Investigated.
   - o ECOs Recommended.
   - o ECOs Rejected.
   - o ECIP Projects Developed. (Provide list)*
   - o Non-ECIP Projects Developed. (Provide list)*
   - o Operational or Policy Change Recommendations.

   * Include the following data from the life cycle cost analysis summary sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date.

6. Energy and Cost Savings.

   - o Total Potential Energy and Cost Savings.
   - o Percentage of Energy Conserved.
   - o Energy Use and Cost Before and After the Energy Conservation Opportunities are Implemented.

ANNEX E
LIST OF MILESTONE DATES

Milestone		Approximate Date
1. Interim Submittal		NTP + 180 days
2. AE receives comments on Interim Submittal		NTP + 218 days
3. Interim Presentation and Review Conference		NTP + 225 days
4. Prefinal Submittal	JULY 24, 1992	NTP + 249 days
5. AE receives comments on Prefinal Submittal	AUGUST 7, 1992	NTP + 271 days
6. Prefinal Presentation and Review Conference	AUGUST 20, 1992	NTP + 285 days
7. Operational and Maintenance Briefing		NTP + 294 days
8. Final Submittal	SEPTEMBER 4, 1992	NTP + 299 days

ANNEX F
SUPPLEMENTAL LIST OF INFORMATION

1. Energy Resources Management Plan

2. ETL 1110-3-254 dated 25 Aug 76. - Use of electric Power for Comfort Space Heating

3. Architectural and Engineering Instructions.

4. Energy Conservation Investment Program (ECIP) Guidance dated 25 April 1988, and the latest revision with current energy prices and discount factors for the life cycle cost analysis.

5. TM 5-785 dated 1 Jul 78. - Engineering Weather Data

6. TM 5-800-2 dated Jun 85. - Cost Estimates Military Construction

7. TM 5-800-3 dated Jul 82. - Project Development Brochure

8. TM 5-802-1 dated 31 Dec 86. - Economic studies for Military Construction Design - Applications

9. TM 5-815-3 dated Sep 90. - HVAC Control Systems (Draft)

10. AR 415-15 dated 1 Jan 84. - Military Construction Army (MCA) Program Development

11. AR 415-17 dated 15 Mar 80. - Cost Estimating for Military Programming

12. AR 415-20 dated Jan 82. - Project Development and Design Approval

13. AR 415-28 dated 1 Dec 81. - Department of the Army Facility Classes and Construction Categories (Category Codes)

14. AR 415-35 dated 15 Oct 83. - Minor Construction, Emergency construction, and Replacement of Facilities Damaged or Destroyed

15. AR 420-10 dated 3 Aug 87. - Management of Directorates of Engineering and Housing

16. AR 11-27 dated 13 Aug 89. - Army energy Program

17. AR 5-4, Change 1 dated 1 Aug 82. - Department of the Army Productivity Improvement Program

ANNEX G
TABLE OF REQUIRED SUBMITTALS

Copies of the reports shall be submitted directly to the Agencies listed below:

AGENCY	REPORTS	EXECUTIVE SUMMARIES	FIELD NOTES
Commander Fort McPherson ATTN: AFZA-FE (Seabrook) Fort McPherson, GA 30330	4	4	1*
Commander U.S. Army Engineer District, Mobile ATTN: CESAM-EN-CC (Battaglia) P.O. Box 2288, Mobile, Alabama 36628-0001	1**	1***	
Commander U.S. Army Engineer Division, South Atlantic ATTN: CESAD-EN-TE (Baggette) 77 Forsythe Street, SW Atlanta, GA 30335-6801	1	1	
Commander, FORSCOM ATTN: FCEN-CDI (Huff) Fort McPherson, GA 30330-6000	2	2	
Commander, HQUSACE ATTN: CEMP-ET (Torabi) Washington, DC 20314-1000		1***	
Commander, U.S. Army Logistics Evaluation Agency ATTN: LOEA-PL (Keath) New Cumberland Army Depot New Cumberland, PA 17070-5007		1***	
Commander U.S. Army Engineer District, Savannah ATTN: CESASEN-PI-9 (Clowser) P.O. Box 889, Savannah, GA 31402	4	4	1*

* Required at the Interim submittal only
** Submit only the prefinal report with the final report correction pages inserted
*** Submit after all the corrections have been made

CONFERENCE NOTES

DATE: 18 June 1991

PROJECT: Energy Savings Opportunity Survey for an EEAP
Ft. McPherson/Ft. Gillem

NOTICE
PREPARED BY: Carl E. Lundstrom
E M C Engineers, Inc.

DATE OF
CONFERENCE: 14 June 1991

PLACE
OF CONFERENCE: DEH Conference Room, Building T-368
Ft. McPherson, Georgia

SUBJECT: Pre-negotiation Meeting

ATTENDEES:
Alfred Clowser, Savannah District COE, (912) 944-5625, FAX 944-5442
Denise Williams, Savannah District COE, (912) 944-5530
Carl Lundstrom, E M C Engineers, Inc., (404) 952-3697
Pawn Chulavatr, E M C Engineers, Inc., (404) 952-3697
Terry Seabrook, DEH Ft. McPherson, (404) 752-3076, FAX 752-4193
Don Heldt, DEH Ft. McPherson, (404) 669-7163
B.V. Sheth, DEH Ft. McPherson, (404) 752-2071
Reg Allen, DEH Ft. Gillem, (404) 363-5270
Jim Mathis, DEH Ft. McPherson, (404) 752-3117

The following is a summary of the items discussed, the comments made, and the discussion made during the conference:

Mr. Clowser discussed the contractual portion of the work and informed EMC to deliver the submittal by UPS to 100 Oglethorp Street, Savannah, GA 31401. Mr. Clowser explained if EMC has any technical questions to talk to Denise Williams at the Savannah District COE.

Mr. Clowser explained survey periods should be coordinated with Terry Seabrook.

Mr. Lundstrom prepared a list of questions for clarification of the scope of work, as follows:

Statement of Work, Paragraph:

2.3 All methods of energy conservation which are reasonable and practicable shall be considered. Does this include items above and beyond Annex A?

Answer: General recommendations will be provided when EMC recognizes an opportunity.

2.10 Please explain ECAM. Does it apply to this project?

Answer: The ECAM does not apply to this project.

7.1 Discuss the number and type of computer energy simulations. Discuss acceptable computer energy simulation programs.

Answer: Par. 3.9 in Annex B & C takes precedent over par. 7.1 in the SOW on computer modeling. EMC will submit computer program descriptions along with the fee proposal.

7.2 What data is available from previous studies?

Answer: No data exists from previous studies.

Annex B, Paragraph:

3.4 Do we need to prepare two LCCA for the two cost estimates?

Answer: The DEH has limited time to spend on site construction. EMC will prepare one LCCA, unless EMC recognizes an opportunity for a low cost/no cost ECO to be performed in-house then; in that event, two LCCAs will be prepared.

3.7 Can EMC invoice monthly for partial payments?

Answer: Yes.

3.8 Is DEH willing to supply enough blueline paper? 89 bldgs * 25 sheets per bldg = 2225 sheets of blueline paper.

Answer: Ft. McPherson will not supply blueline machine nor paper. EMC can bring a blueline machine on post and Ft. McPherson will provide working space. Mrs. Seabrook will check on refiling of prints.

ECO list, Paragraph:

1. Do you want EMC to identify potential asbestos insulation? Sample, test, and log? Are there any asbestos abatement project in funding cycles?

Answer: EMC will use Ft. McPherson's list of buildings with asbestos.

2. Do you want to consider double glazing, and various types of shaded or reflective glass?

   Answer: No; insulation only.

8. Do you want us to take volt, amp, power factor, kW, kVAR, and kVA readings on each motor? Motors over 5 hp?

   Answer: Yes; 10 hp and larger.

9. When we say economizer cycles, do you want EMC to evaluate modifying the HVAC systems to add duct work, dampers, and controls?

   Answer: Yes; modify the HVAC systems to add duct work, dampers, and controls.

   Or do you want to only modify controls on HVAC system with ducts with 100% OA and RA capability?

   Answer: No.

   What about evaluation of required minimum OA ventilation?

   Answer: Yes; evaluate minimum OA ventilation.

10. Is HW circulation pumps referring to domestic HW or space heating circulation pumps? What type HW circulation controls do you want us to consider? Timeclocks, EMCS, OA reset and optimization controls?

    Answer: "HW circulation pumps" refers to domestic HW and space heating circulation pumps. HW circulation controls will include OA reset.

11. Do you want EMC to consider tank or tankless DW heaters?

    Answer: Delete from project.

12. Do you want EMC to also consider faucet flow resistors on sinks?

    Answer: Yes.

17. Do you want EMC to also consider retrofitting new lamp types or fixtures?

    Answer: EMC will survey and make a recommendation.

22. Do you want EMC to test all the HVAC controls to see if they need repair?

<u>Answer:</u> EMC will make recommendations. Buildings 101, 102, and 133 at Ft. Gillem and Buildings 65 and 184 at Ft. McPherson are removed from the project.

How do you want to handle possible controls work to be done under future shared energy savings contract, versus footnote in Annex A regarding HVAC controls to be COE standard control panel design?

<u>Answer:</u> EMC will perform the survey with regard to Annex A, HVAC controls to be COE standard control panel design.

26. Do you want EMC to consider ultrasonic and passive infrared automatic controls?

<u>Answer:</u> Yes.

27. Please expand on the description of "investigate post demand usage."

Do you want EMC to do power metering on buildings and loads? How many buildings and loads?

<u>Answer:</u> No metering. EMC will use a simple approach to evaluate and reduce post electric demand.

28. Please expand on the description of shutdown boilers versus continuous operation?

<u>Answer:</u> Shutdown boilers may cause higher maintenance than continuous operation.

** Are all the buildings listed in the "ECO/Building Check List" ?

<u>Answer:</u> Yes.

<u>Other ECOs to consider:</u>

Steam trap ECO's, steam trap survey?

<u>Answer:</u> No.

<u>Annex E, Paragraph:</u>

What is the preliminary estimate of dates?

Answer: Mr. Clowser will discuss these deadlines with EMC.

Annex F, Paragraph:

e. Do you want EMC to test boiler combustion efficiency?

Answer: Delete from the project.

General:

1. Are there any secure areas where we'll need escorts?

   Answer: Yes; Buildings 200 and 363 at Ft. McPherson and Buildings 101, 213, and 505 at Ft. Gillem.

2. Are there any areas which will require asbestos suits and respirators?

   Answer: No.

3. What type and age of hospital are buildings 170 and 171?

   Answer: Buildings 170 and 171 are clinic type buildings.

Carl E. Lundstrom

Carl E. Lundstrom, P.E.

CONFIRMATION NOTICE

Confirmation No. 1 EMC #P30F.010

DATE: 24 June 1991
To/From: Denise Williams Phone # (912) 944-5530
Representing: Savannah District, Corps of Engineers

PROJECT: Energy Savings Opportunity Survey for an EEAP
Ft. McPherson/Ft. Gillem

NOTICE
PREPARED BY: Carl E. Lundstrom
E M C Engineers, Inc.

SUBJECT: Scope of Work Clarification

The following is a summary of the items discussed, the comments made, and the decisions made during the telephone conversation:

This is to confirm a telephone conversation on 24 June 1991 between Ms. Denise Williams and Mr. Carl Lundstrom regarding clarification of the Scope of Work dated 18 June 1991 for the above referenced project.

Mr. Lundstrom asked Ms. Williams if she could identify the scope of work paragraph section that described the "Operational and Maintenance Briefing" listed in Annex E, item 7.

Ms. Williams explained there was no paragraph section listing the requirements of the Operational and Maintenance Briefing; however, the briefing was meant to be a basic briefing for the maintenance staff, to be given at Ft. McPherson, to discuss the results of the study. EMC would not have to prepare any additional submittals or training material for this briefing.

Carl E. Lundstrom

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

CONFIRMATION NOTICE

Confirmation No. 2 EMC #P30F.013

DATE: 8 August 1991

PROJECT: ENERGY SAVINGS OPPORTUNITY SURVEY (ESOS)
FORTS McPHERSON AND GILLEM, GEORGIA

CONTRACT NO. N/A

NOTES
PREPARED BY: Carl E. Lundstrom
E M C Engineers, Inc.

DATE OF
CONFERENCE: 7 August 1991

PLACE OF
CONFERENCE: U.S. Army Engineer Corps of Engineer
Savannah District Offices
Savannah, Georgia

SUBJECT: To discuss the Scope of Work, provide clarification, and general fact finding.

ATTENDEES: Al Clowser, Savannah District COE
Denise Williams, Savannah District COE
Lucie Hughes, Savannah District COE
Dick Hanna, Savannah District COE
Carl Lundstrom, E M C Engineers, Inc.

Mr. Lundstrom explained the detailed fee proposal breakdown, task–by–task, explaining the approach and level of detail involved in the survey, analysis, and report writing. The attendees discussed each task. The following is a summary of the items discussed, the comments made, and the resolutions made during the fact finding conference:

1. ECO 4: "Measure and record the water temperature of hot water heaters." EMC will only measure and document the domestic hot water temperatures. EMC will not evaluate any modification or change to the domestic water heaters.

2. ECO 6: "Add economizer cycles (dry bulb) and evaluate minimum outside air levels." EMC will not be required to take outside air (OA) flow measurements on existing HVAC systems. EMC will make engineering estimates of the OA

quantities from observations of the HVAC equipment and design drawings.

3. ECO 16: "Investigate post demand usage." The level of survey and analysis for this ECO will involve:

   - EMC will spend approximately one day at each site identifying potential electrical loads which could be shed, or generators which could be used to lower demand.

   - EMC will try to obtain demand information from the power company to identify the time and quantity of the peak electrical demand.

   - The A/E will provide a list of recommended ways the Fort should investigate lowering demand. No savings analysis or cost estimates will be required.

4. ECO 17: "Evaluate boiler operation." EMC will not be required to take any combustion efficiency tests for this ECO.

5. ECO project analysis, Section 7.3 of the Scope of Work: After combining ECO projects (after the interim submittal), EMC will not be required to reevaluate energy savings to take into account synergistic effects of multiple ECOs within a project and the effects of one project upon another. EMC will basically take the savings and cost estimates for ECOs directly from the interim submittal analysis and add them together to create proposed ECIP projects.

6. ECIP projects, Section 5.1: EMC will not be required to prepare any DD1391's or PDB's.

7. Non–ECIP projects, Section 5.2 of the Scope of Work: EMC will not be required to prepare any forms for QRIP, OSD PIF, or PECIP funding. EMC will only provide brief project descriptions and life cycle cost, and place the ECO in a category for non–ECIP funding.

8. The level of narrative text expected on the interim submittal is 40 pages, plus a few pages for a narrative summary. The final submittal will include approximately 10 more pages to describe project analysis, ECIP funding, non–ECIP funding, and executive summary.

Carl E. Lundstrom, P.E.

If any portion of this confirmation notice is incorrect, please notify us immediately.

CONFIRMATION NOTICE

Confirmation No. 3 EMC #P30F.013

DATE: 8 August 1991

PROJECT: ENERGY SAVINGS OPPORTUNITY SURVEY (ESOS)
FORTS McPHERSON AND GILLEM, GEORGIA

CONTRACT NO. N/A

NOTICE
PREPARED BY: Carl E. Lundstrom
E M C Engineers, Inc.

SUBJECT: Clarifications to the scope of work.

This is to confirm a telephone conversation on 8 August 1991 between Denise Williams, Savannah District COE, and Carl Lundstrom, E M C Engineers, Inc., regarding clarifications to the scope of work.

- EMC will evaluate thermal storage for Buildings 200 and 246 using computer simulations analysis. EMC at their option may evaluate thermal storage for building 187 using computer simulations or hand calculations.

- EMC will evaluate HVAC economizers for Buildings 184, 246, and 500 using computer simulation analysis. EMC at their option may evaluate HVAC economizers for the other buildings noted in Annex B and Annex C, using computer simulations or hand calculations.

Carl E. Lundstrom, P.E.

If any portion of this confirmation notice is incorrect, please notify us immediately.

CONFIRMATION NOTICE

Confirmation No. 4 EMC #3105.000

DATE: 21 October 1991
To/From: Earl Jenkins (912) 944-5629
Savannah District COE

PROJECT: ENERGY SAVINGS OPPORTUNITY SURVEY (ESOS)
FORTS McPHERSON AND GILLEM, GEORGIA
CONTRACT NO. DACA21-91-C-0097

NOTES
PREPARED BY: Carl E. Lundstrom
E M C Engineers, Inc.

SUBJECT: Reaffirm earlier Confirmation Notices discussed with and confirmed as accurate by Al Clowser.

This is to confirm a telephone conversation on 21 October 1991 between Earl Jenkins, Project Manager, Savannah District COE, and Carl E. Lundstrom, Project Manager, E M C Engineers, Inc.

1. Mr. Jenkins affirmed to Mr. Lundstrom that all the previous confirmation notices and conference notes prepared during contract negotiations are effective toward defining the scope of the project. Previous confirmation notices and conference notes include:

   - Confirmation notice 1., 24 June 1991
   - Confirmation notice 2., 8 August 1991
   - Confirmation notice 3., 8 August 1991
   - Conference notes, dated 18 June 1991

Carl E. Lundstrom

Carl E. Lundstrom

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

CONFIRMATION NOTICE

Confirmation No. 5 EMC #3105.000

DATE:	15 November 1991
PROJECT:	Energy Savings Opportunity Survey for an EEAP Ft. McPherson/Ft. Gillem
NOTICE PREPARED BY:	Pawn Chulavatr E M C Engineers, Inc.
DATE OF CONFERENCE:	14 November 1991
PLACE OF CONFERENCE:	DEH Conference Room, Building T-368 Ft. McPherson, Georgia
SUBJECT:	Entrance Interview
ATTENDEES:	Earl Jenkins, Savannah District COE, (912) 944-5622, FAX 944-5442 Denise Williams, Savannah District COE, (912) 944-5530 Carl Lundstrom, E M C Engineers, Inc., (404) 952-3697 Pawn Chulavatr, E M C Engineers, Inc., (404) 952-3697 Terry Seabrook, DEH Ft. McPherson, (404) 752-3076, FAX 752-4193 Jim Mathis, DEH Ft. McPherson, (404) 752-2207 Naresh Kapur, HQ FORSCOM, (404) 669-6731

The following is a summary of the items discussed, the comments made, and the decisions made during the conference:

Mrs. Seabrook welcomed everyone to the meeting. Mr. Jenkins introduced himself and explained the administrative portion of the project. Mr. Jenkins has replaced Mr. Alfred Clowser as the COE Project Manager. Mr. Jenkins requested that EMC show the dates of report revisions on the report covers. Mr. Jenkins requested that an extra copy of the pre-final report and the executive summary be send to the U.S. Army Engineering District, Mobile, HQUSACE, and to the U.S. Army Logistic Evaluation Agency.

Address corrections for the following agencies are listed below:

- Commander
  Fort McPherson
  ATTN: AFZK-EH (Seabrook)
  Fort McPherson, GA 30330

- Commander, FORSCOM
  ATTN: FCEN-RDF (Kapur)
  Fort McPherson, GA 30330-6000

- Commander
  U.S. Army Engineering District, Savannah
  ATTN: CESASPM-MP (Jenkins)
  P.O. Box 889
  Savannah, GA 31402

Mr. Lundstrom reviewed the EMC handout and discussed the field survey, analysis, and report preparation in detail. Mr. Lundstrom explained that several ECOs may be partially funded by Georgia Power Co. EMC will investigate this concept and include it in the ECO analysis. Mr. Lundstrom asked the following questions regarding the field survey:

Q. What steps are necessary to survey secured buildings?
A. Mrs. Seabrook replied that Buildings 200 and 363 at Ft. McPherson and Building 101 at Ft. Gillem will require advance notice for an escort. Mr. Lundstrom will compile a building survey list schedule and coordinate with Mrs. Seabrook.

Q. How is access obtained to secured building plans?
A. Mr. Kapur explained that FORSCOM does not allow secure building plans to be copied. However, the plans can be visually reviewed in order to investigate ECOs. Mr. Jenkins will also check the COE files in Savannah for secured building plans.

Q. Is there a master mechanical room key?
A. Mrs. Seabrook will provide EMC with the necessary mechanical room keys, with the exception of the secured buildings; escort personnel will have keys for secured buildings.

Q. Can DEH provide EMC with temporary car passes?
A. Yes.

Q. Will EMC be provided with shop personnel's names and telephone numbers?
A. Mrs. Seabrook will introduce EMC to shop personnel prior to the survey.

Mrs. Seabrook requested a list of the people who will be performing the field survey. Mr. Lundstrom will provide Mrs. Seabrook with the list.

Ft. McPherson and Ft. Gillem will each receive separately bound reports.

Mrs. Seabrook requested that items be added to the building survey form (enclosed in the EMC handout). EMC will coordinate with Mrs. Seabrook.

Mr. Kapur provided an example outline of the executive summary. Mr. Kapur also discussed the following items:

- EMC should contact PNL for information on demand side management.
- ECO cost estimates should include cross-reference information and labor and material costs.
- Each ECO should include ECO descriptions and sketches. ECOs which have no energy savings should be indicated.
- More emphasis was requested on ECOs regarding lighting. (Mrs. Seabrook has previously reviewed the interior lighting ECO.)
- Before the review meeting, there should be a site walk through the representative buildings included in proposed ECOs for the project.
- Exit signs should be counted during the building survey.
- A solar lighting project should be explored.

Mrs. Seabrook stated that the exterior lighting at Ft. McPherson is being maintained by Cleo. EMC will contact Cleo for exterior lighting information.

The following reports were provided to EMC:

- Feasibility Study for Lighting Shared Energy Saving Project at Ft. McPherson and Ft. Gillem, July 1990.
- RFP Paid from Shared Energy Saving Projects at Ft. McPherson and Satellite Installations, August 1991.

Carl Lundstrom

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

CONFIRMATION NOTICE

Confirmation No. 6 EMC #3105.000

DATE: 17 December 1991
TO/From: Earl Jenkins
Representing: U.S. Army Engineering District, Savannah

PROJECT: Energy Savings Opportunity Survey for an EEAP
Ft. McPherson/Ft. Gillem

CONTRACT No.: DACA21-91-C-0097

NOTICE
PREPARED BY: Carl E. Lundstrom
E M C Engineers, Inc.

SUBJECT: Interim Submittal Date Change

The following is a summary of the items discussed, the comments made, and the decisions made during the telephone conversation:

This is to confirm a telephone conversation on 17 December 1991 between Earl Jenkins and Carl Lundstrom, in which Mr. Lundstrom requested a change in the schedule date for the Interim Submittal. The new schedule date was agreed to be 30 April 1992.

____
Carl Lundstrom

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

CONFIRMATION NOTICE

Confirmation No. 7 EMC #3105.000

DATE: 28 January 1992
To/From: Terry Seabrook

PROJECT: Energy Savings Opportunity Survey for an EEAP
Ft. McPherson/Ft. Gillem, GA

CONTRACT NO. DACA21-91-C-0097

NOTICE
PREPARED BY: Ron Gerrans
E M C Engineers, Inc.

SUBJECT: Adjustment to Building Energy Conservation Opportunities (ECO) List

The following is a summary of the items discussed, the comments made, and the decisions made during the meeting on 28 January 1992 between Carl Lundstrom and Terry Seabrook regarding adjustments to the building ECO list. From this meeting the following changes to the building ECO list were recommended:

- Fort Gillem: EMC will drop the following buildings from the ECO list because the buildings are scheduled for demolition:

  - Fort Gillem: 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 918, 922, 923, 942

- EMC will create a new ECO. ECO 18 will be to convert existing incandescent exit signs to fluorescent. EMC will do this for the following buildings:

  - Fort McPherson: 041, 056, 058, 060, 062, 101, 170, 171, 181, 184, 200, 246, 363, 366, 400, 401
  - Fort Gillem: 101, 103, 207, 213, 400, 401, 512, 935

- For ECO 1, EMC will add Fort McPherson Bldg. 360

- For ECO 6, EMC will add Fort McPherson Bldg. 181

- For ECO 8, EMC will add the following buildings:

  - Fort McPherson Bldg. 363 and 400
  - Fort Gillem Bldg. 935

- For ECO 12, EMC will investigate special HVAC control applications on Fort McPherson Bldgs. 100, 131, 170, 171, 200

- For ECO 13, EMC will add the following buildings:
  - Fort McPherson Bldgs. 060, 170, 171, 181, 184, 363, and 500
  - Fort Gillem Bldg. 101
- For ECO 15, EMC will add Fort McPherson Bldg. 200
- In addition, we will update the technical information from the Battelle and Stone & Webster lighting surveys to analyze the possibility of a Government ECIP project instead of the proposed shared energy savings project.

Ronald M. Gerrans

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

CONFIRMATION NOTICE

Confirmation No. 8 EMC #3105.000

DATE:	4 March 1992
PROJECT:	Energy Savings Opportunity Survey for an EEAP Ft. McPherson/Ft. Gillem
CONTRACT No.:	DACA21-91-C-0047
NOTICE PREPARED BY:	Kamchornvuthi Chulavatr E M C Engineers, Inc.
DATE OF CONFERENCE:	19 February 1992
PLACE OF CONFERENCE:	DEH Conference Room, Building T-368 Ft. McPherson, Georgia
SUBJECT:	Exit Interview
ATTENDEES:	Earl Jenkins, Savannah District COE, (912) 944-5622, FAX 944-5442 Denise Williams, Savannah District COE, (912) 944-5530 Carl Lundstrom, E M C Engineers, Inc., (404) 952-3697 Kamchornvuthi Chulavatr, E M C Engineers, Inc., (404) 952-3697 Ron Gerrans, E M C Engineers, Inc., (404) 952-3697 Jim Mathis, DEH Ft. McPherson, (404) 752-2207 Naresh Kapur, HQ FORCOM, (404) 669-6731 Gene Reardon, Chief ERMD, (404) 952-4299 Barbara ZaKrzewski, DEH Housing, (404) 752-3381 Miles Wilson, JR., Deputy DEH, (404) 752-3258 LTC C.A. McNair, JR., DEH, (404) 752-2161

The following is a summary of the items discussed, the comments made, and the decisions made during the conference:

Mr. Lundstrom started the meeting by described the survey effort and pointing out probable areas of energy conservation identified during the survey.

Mr. Lundstrom described the project plan for work following the survey. Mr. Lundstrom then discussed the survey findings for each ECO in detail.

Mr. Chulavatr gave slide presentation of representative buildings.

Mr. Lundstrom solicited advice from DEH to resolve the following issues concerning ECOs to be evaluated:

- Window modification on historical buildings – the replacements can be double glass pane with wood frame and sash. The appearance of the new windows must be the same as the original windows.

- HVAC control – the HVAC control should be evaluated based on the life cycle cost analysis of the control system. The emphasis of the control system shall be based on the cost, maintenance, ease of operation, and energy conservation capability.

- Automatic light switch – Mr. Lundstrom proposed ideas for the automatic lighting control systems, which were included in the handout. The approaches were acceptable to DEH.

- Ventilation & recirculation – Mr. Lundstrom proposed an exhaust fan which can perform air stratification, recirculation, and exhaust, all in one unit. This unit will be evaluated for warehouses at Ft. Gillem. The approach was acceptable to DEH.

- Reduce street lights – Mr. Lundstrom proposed to change this ECO to replace mercury vapor street lights with high pressure sodium street lights. The approach was acceptable to DEH.

Mr. Lundstrom proposed two additional ECOs for buildings at Ft. McPherson and Ft.Gillem. The two new ECOs are:

- ECO 18 – exit sign conversion
- ECO 19 – incorporate lighting studies done by other A/Es for shared savings

The DEH agreed for EMC to incorporate the two new ECOs in the study, as identified in the handout.

Mr. Kapur asked EMC to include a section in the report to discuss other energy conservation project considerations. Mr. Wilson commented on the manpower savings of the 4–pipe fan coil over the 2–pipe fan coil system.

Kamchornvuthi Chulavatr

Kamchornvuthi Chulavatr

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CONFIRMATION NOTICE

Confirmation No. 9 EMC #3105.000

DATE:	6 March 1992
PROJECT:	Energy Savings Opportunity Survey for an EEAP Ft. McPherson/Ft. Gillem
CONTRACT No.:	DACA21-91-C-0047
NOTICE PREPARED BY:	Jim Watters E M C Engineers, Inc.
DATE:	6 March 1992
SUBJECT:	Trace 600
ATTENDEES:	Denise Williams, Savannah District COE, (912) 944-5530 Jim Watters, EMC Engineers Inc. (404) 952-3697

This is to confirm a telephone conversation on the 6th of March between Denise Williams, Savannah COE, and Jim Watters, EMC Engineers, regarding the use of the Trace 600 for this project. Ms. Williams approves the Trace 600 computer simulation program.

Jim Watts

Jim Watters

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

CONFIRMATION NOTICE

Confirmation No. 10 EMC #3105-000

Date:	29 June 1992
PROJECT:	Energy Savings Opportunity Survey for EEAP Ft. McPherson/Ft. Gillem, GA
CONTRACT NO.:	DACA 21-91-C-0097
NOTES PREPARED BY:	Carl E. Lundstrom E M C Engineers, Inc.
DATE OF CONFERENCE:	25 June 1992
PLACE OF CONFERENCE:	DEH Conference Room Ft. McPherson, GA
SUBJECT:	Presentation of Findings and Interim Report Review Comments
ATTENDEES:	Terry Seabrook, Installation Energy Coord., DEH (404) 752-3076 Carl Lundstrom, E M C Engineers, Inc. (404) 952-3697 Chris Stanley, E M C Engineers, Inc. (404) 952-3697 Don Heldt, Foreman, OPS Branch, DEH OOH (404) 669-7163 Buddy Rappola, Maint. Mech. Superv., DEH FESD (404) 363-5411 John Rose, Gov't Sales, GA Power Co. (404) 526-3569 Dennis Lindemeier, Proj. Mgr., Savannah COE (912) 652-5623 Denise Williams, Mech. Engr., Savannah Dist. COE (912) 652-5530 Naresh Kapur, Mech. Engr., FORSCOM Engr. (404) 669-6731 Harry H. Foster, DEH O&M (404) 752-2686 Gwen Harvey, Dist. Rep.-Gillem, GA Power (404) 362-5449 Herb Joseph, Dist. Rep.-Gillem, GA Power (404) 362-5449 Jim Mathis, Ch., Engr, Plns & Svs Div., DEH (404) 752-2207

The following is a summary of the items discussed, the comments made, and the decisions made during the Conference:

1. Mr. Lindemeier introduced persons attending the meeting and gave the purpose for the review conference.

2. Mr. Lundstrom gave a presentation of the findings of the Interim Submittal, along with the recommendations to date.

3. General items discussed during a question and answer period include:

- Mr. Heldt: The motor readings taken in Building 200 need some description to inform the reader that a majority of the motors are variable speed and that the readings are taken at a part load. Mr. Lundstrom acknowledged this concern and agreed to add clarification.

- Mr. Kapur: Wanted to know if any exterior light readings were taken related to ECO 11. Mr. Lundstrom explained he remembers light readings were taken, and agreed to verify this and provide light readings for the report.

- Mr. Heldt and Ms. Seabrook: Would like to know more about the lighting control system for Building 200. There is concern about the number of telephone extensions and devices that would be required. Mr. Lundstrom agreed to provide additional catalog data for lighting control systems.

Interim submittal review comments were discussed. The following are the responses to review comments received from U.S. Army Corps of Engineers, Savannah District, and Ft. McPherson on the Interim Submittal.

<u>REVIEWER: NARESH KAPUR, 4 JUNE 1992</u>

Item No.	Review Action
1.	Thank you for the compliment.
2.	A, EMC tried to follow the format discussed. EMC will review descriptions and make improvements in format. Also see discussion in Confirmation Notice No. 2, item 8.
3.	A, EMC will look into the new Natural Gas rate structure and make any necessary corrections.
4.	A, EMC will look into the water and sewage rates and make any necessary corrections.
5.	D, the $0.0255/kWh rate is based on low load factor, which is justified. No change.
6.	A, If the GA PSC decision is out by 7 July 1992, EMC will incorporate Demand Side Management credits into analysis of projects for final report.
7.	A, EMC will try to incorporate non-energy savings where feasible.
8.	A, EMC will reevaluate to take leakage into consideration.

9. A, This was not part of the Scope of Services. EMC will do a separate sample calculation for one building for Mr. Kapur directly. It is not intended to include this as part of the submittal.

10. A, Construction cost figures were obtained from 1992 "Means." Non-energy savings are very hard to quantify. EMC will reverify costs.

11. A, 0.0's will be replaced with blanks or NA.

12. A, EMC will discuss with DEH any projects they feel can be done in-house.

REVIEWER: WILLIAMS, 8 JUNE 1992

Item No. Review Action

1. A, Concur. Will correct.

2. A, Concur. Will correct.

3. A, Concur. Will correct.

4. A, Concur. Will correct.

5. A, Buildings were inadvertently left off list. Will correct.

6. A, Building 100 was adequately insulated. Savings factors were calculated by removing insulation from Building 100 and resimulating.

7. A, Concur. Will correct.

8. A, Concur. Will correct.

9. A, Concur. Will add.

10. A, .8 gpm per 10 tons is a factor from the Table on page C-9.3 which is used to obtain a 65°F temperature rise. Will clarify.

11. A, Btu figure is from computer simulation for Building 207. Will clarify.

12. A, Concur. Will correct.

13. A, Concur. Will correct.

14. A, Concur. Will correct.

15. A, The increase is actually a savings. Wording will be changed to clarify.

16. A, Concur. Will correct.

17. A, See Item No. 10.

18. A, Calculations are contained within spreadsheet. This is just a sample calculation. Will clarify calculation as per Item No. 11.

19. A, We will attach references. The spreadsheet calculations follow the format of the energy consumption calculations on Pages C-14.2.5 - C-14.2.8.

REVIEWER: TWITTY, 15 JUNE 1992

Item No. Review Action

1. A, The correct construction cost is $172,912. There was a wrong number in the table that will be corrected. No change in payback.

2. A, This cost is due to the size of the building and the complexity of the control system. We will look further into the control system and connections to the existing EMCS system. The occupancy sensors described on pages 3-63 and 3-64 are designed to replace existing light switches.

REVIEWER: JOSEPH, 25 JUNE 1992

Item No. Review Action

Regarding Table 3-26, on page 3-67

D, The correct reference is page 3-76. The columns are correct. No change.

REVIEWER: SEABROOK

Item No. Review Action

1. A, Will add legend to all pages.

2. A, Will correct building numbers.

3. A, Will correct.

4. A, Will revise.

5. A, Will add LCCA summary.

6. D, Defer comment to Savannah District. Mr. Lindemeier will prepare milestone dates for completion of the project.

7. A, Will add.

REVIEWER: HELDT/FOSTER

8. A, Will correct table.

9. A, Will clarify.

10. A, Will review, correct, and clarify.

11. A, Will review, correct, and clarify.

12. A, Will correct recommendations.

13. A, Will correct errors in Table.

14. A, Will add clarification.

15. A, Will correct figure.

16. A, Will add heading to columns.

GEN. A, Will correct Table of Contents for Appendices.

Carl E. Lundstrom, P.E.
Project Manager

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

CONFIRMATION NOTICE

Confirmation No. 11 EMC #3105-000

Date:	29 June 1992
PROJECT:	Energy Savings Opportunity Survey for EEAP Ft. McPherson/Ft. Gillem, GA
CONTRACT NO.:	DACA 21-91-C-0097
NOTES PREPARED BY:	Carl E. Lundstrom E M C Engineers, Inc.
DATE OF CONFERENCE:	2 July 1992
PLACE OF CONFERENCE:	DEH Conference Room Ft. McPherson, GA
SUBJECT:	To Identify Non-appropriated Fund Facilities

This is to confirm a meeting with Terry Seabrook and Tom Baldwin of the Ft. McPherson Directorate of Engineering and Housing, and Carl Lundstrom of EMC Engineers, Inc. The following is a summary of the items discussed, the comments made, and the decisions made.

1. The following buildings are not to be included in energy projects developed for ECIP funding, because they are NAF facilities which pay for their own utilities:

   Ft. McPherson:

   - Bldg 155, NCO Club
   - Bldg 360, Commissary
   - Bldg 500, Dining Facility

   Ft. Gillem:

   - Bldg 133, Community Center, Club
   - Bldg 214, Commissary
   - Bldg 505 through 514, Warehouses (AAFES)

2. Mr. Baldwin explained the following buildings at Ft. McPherson will be torn down shortly to accommodate the construction of a new medical facility. These buildings should not be included in energy projects development:

- 116, Administration
- 117, Classroom
- 118, Administration
- 120, Administration
- 121, Administration
- 122, Administration
- 124, Administration
- 126, Administration

Carl E. Lundstrom, P.E.
Project Manager

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Project Review Comments: Energy Savings Opportunity Survey (ESOS) Forts McPherson/Gillem

Reviewed by: SEABROOK

Item No.	Paragraph No.	Comments	ACTION
1	Pg E-5 Ft Mac	Table E5.3 - Building ECO Matrix shall include legend on all pages.	A - Added legend to all pages of table.
2	Pg 3-49 Ft Mac	Correct building number in Field survey listing.	A - corrected building no's
3	Pg 3-3 Ft Mac	Add ECO 10 & 17 to Table 3.2 (Nonfeasible ECOs)	A - Added ECO's to table 3.2.
4	Pg 3-55 ECO 12 Ft Mac	Bldgs 131, 168, 170 & 171 Revise or Repair HVAC Controls - These buildings do not have boilers. They use steam.	A - Changed reference from boiler to converter, and corrected numbers.
5	Appendix C-7 Ft Mac	Where is the Life Cycle Cost Analysis.	A - Added LCCA Sheet for ECO 7
6	E1 Both Forts	List Milestone Dates as Real/Actual Dates	A - Added dates from letter received from cont. officer. 30 June 1992
7	Gen	Life Cost Analysis Summary Investment - Where is 1F and 3B. 1E	A - Changed 1F to 1E on sheets. 3B is not used. This is a gov't provided program.
Heldt/Foster			
8	Pg 3-11 Ft Mac	Occupancy for Bldg. 200 is in error.	A - Corrected schedule on page 3-11.
9	Pg 3-49 Ft Mac	Error in building. Please clarify.	A - Added clarification.

Project Review Comments: Energy Savings Opportunity Survey (ESOS) Forts McPherson/Gillem

Item No.	Paragraph No.	Comments	ACTION
Heldt/Foster			
10	Pg 3-56 Ft Mac	EMCS is already staging units off line during unoccupied periods.	A - Additional clarification provided.
11	Pg 3-59 Ft Mac	Do not undertstand entry for Bldg. 200. Explain.	WD
12	Pg 3-60 Ft Mac	"Recommendations" - ?	A - Recommendations provided.
13	Pg C5.5 C5.6 C5.11/C5.12	Many errors in readings and specs. Subject to question. Use of variable frequency drives not discusse. Explain.	A - Errors corrected. Economy of variable speed drives provided.
14	Pg C12.16 Ft Mac	Do not understand at all Explain.	A - Additional clarification provided.
15	Pg C13.3 Ft Mac	Schematic not correct.	A - Schematic corrected.
16	Pg C15.1.6 Ft Mac	Explain calculations.	A - Calculations clarified.
SEABROOK	Gen	Volume II Appendix E conflicts the Table of Contents. See Appendix F.	A - Corrected Table of Contents.

5 JUNE 92

FCEN-RDF

MEMORANDUM FOR COMMANDER, US ARMY ENGINEERING DISTRICT, SAVANNAH, ATTN: CESAS-PM-MP/MR. EARL JENKINS, 100 W. OGLETHORPE AVENUE, SAVANNAH, GA 31402

SUBJECT: Energy Saving Opportunity Survey for an EEAP, Fort McPherson/Gillem, GA

1. We received two copies of Volume I, Interim Submittal, Executive Summary, Appendices A-D of the subject energy study from EMC Engineers Inc. Our review comments are enclosed. We are very impressed with EMC Engineers efforts and responsive attitude despite difficulties involved in conducting an EEAP study.

2. Please let us know when a meeting to discuss the review comments and EMC Engineers' response is scheduled. Mr. Kapur, COMM 404-669-6731, can provide you additional information on the subject matter.

FOR THE ENGINEER:

Encl

RONALD D. BENTSEN
Chief, Resources Division

MFR: Due to other commitments, we are a little behind on providing review comments to Savannah Dist.

____________________RELEASED BY____________________
Kapur/6731/cm/5 Jun 92/ECIPCMTM

Stoudenmire Date

____
Bentsen Date

6/5/92
1350

Earl Jenkin 912-652 5822, ~~FAX~~
Told him that will mail the Review comments ASAP. If he is in a bind let us know, we can FAX the Cmts to him. He said - no big hurry.

FORSCOM ECIP REVIEW COMMENTS DATE: 6/4/92 PG 1/2

PROJECT: ENERGY SAVING OPPORTUNITY SURVEY, FT MCPHERSON/GILLEM

REVIEWER: NARESH KAPUR, PE, FCEN-RDF, TEL: 404-669-6731/FAX-7751

ITEM NO.	PARA# PAGE#	COMMENT	REVIEW ACTION
1.	Gen	The following comments are related to Ft McPherson but the same comments should be considered for Ft Gillem as applicable. AE HAS DONE ACCOMMENDABLE JOB.	NO Action Req'd
2.	Gen	ECO description should briefly discuss the current situation, situation after completion of ECO and method of accom plishment. We encourage sketches, and catalog type info wherever practical.	A - Added current situation descipt.
3.	2.2.2 2-2	Look into the current Natural Gas rate structure effective recently. Gas rates consist of six parts as follows: Monthly customer charge; Firm use charge; Consumption charge; Firm purchase gas adjustment; Interruptible purchase gas adjustment; Other misc. charges (Franchise recovery and take or pay). The current monthly customer charges are $800 for McPherson and $1,000 for Gillem. Firm use charges are $10,400 for Gillem. Consumption Charges are $0.07/therm for 1st 100,000 therms. For next 200,000 therms, $0.057/therm. Gas adjustment charge of $0.397/therm is for firm supply and charges for interruptible supply is much less.	A - Obtained new rates from AGL. Used revised rates.
4.	2.2.3 2-3	Water and sewage rates are different for McPherson and Gillem.	A - Revised rates.
5.	2.5.2 2-9	Average energy charge used is 0.0255/Kwh. Does it assume all energy reduction in high load factor block? Can this be justified?	W.D.
6.	2.6 2-10	Latest Info. GA PSC decision due 7/7/92.	A - GA PSC decision on 7/7/92 had no info related to this study. No change.
7.	3.4	ECO Analysis. Cosider non-energy savings wherever possible. Example: New surface provided by wall insulation may need less maintenance and upkeep for some time.	A - Labor savings added to ECO 12 see App C and D.

FORSCOM ECIP REVIEW COMMENTS DATE: 6/4/92

PROJECT: ENERGY SAVING OPPORTUNITY SURVEY, FT MCPHERSON/GILLEM

REVIEWER: NARESH KAPUR, PE, FCEN-RDF, TEL: :404-669-6731, FAX-7751

ITEM NO.	PARA# PAGE#	COMMENT	REWIEW ACTION
8.	3.4.1 3-17	In the ECO, do we recognize leakage of conditioned air as a source of energy waste? If so, AE should consider fixing leakage as part of the ECO.	A - Added leakage to insulation calculations
9.	3.4.2 3-23	Consider Window Quilts for insulation and comfort. Addl info available with Mr. Kapur. Fort Drum used it recently.	A - An example calculation for window quilts was provided sep. from report/study.
10	3.4.3 3-30	Weatherstripping and caulking. PB is high. AE is requested to recheck const cost figures and possible non-energy savings due lower annual maintenance cost. In the current guidance, 100% nonenergy savings are allowed in Economic analysis. Mr Kapur has the info.	A - Costs were checked against cost estimate guides. Further clarifica[illegible] was added to the report.
11.	4.1 4-3	In different tables, SIR or PB value of 0.0 is misleading. AE may consider leaving it blank or using NA etc.	A - Tables were revised to show blanks.
12.	Gen	Wherever PB of an ECO is more than 8 years, AE is requested to check if inhouse accomplishment can provide desirable payback.	A - McPherson does not feel it has adequate staffing to accomplish ECOs except as noted for low cost/ no cost ECOs

PROJECT COMMENTS Date: 8 Jun 1992 Page 1 of 2

Project: Energy Savings Opp. Survey
Site(s): Ft. McPherson, GA
FY: 1992
LI: 2006000
CN:

To: EMC Engineers Inc.
Thru: PM-MP/Lindemeier
Thru: EN-D/Lupton
Thru: EN-DF/Hughes
From: EN-DF/Williams

____Foundation Report
____10% Submittal
____Concept Submittal
_X_ Interim Submittal
____Preliminary Submittal
____Pre-Final Submittal
____Final Submittal
____VE Study
____Annotated Comments
____Customer Comments
____Correspondence
____Corrected Final

Item	Refer	Comment	Action
1.	General	The payback should be as shown on the LCCA sheet. The payback shown on the summary tables is different.	A - Paybacks corrected.
		Volume I of Ft. McPherson study	
2.	pg ES-2	Indicate that ECO 4 is only to record water temperatures and does not involve calculations.	A - Note added to Table to indicate measurement only.
3.	pg ES-4	Add ECO 17 to the list of non-feasible ECOs.	A - Added ECO to Table.
4.		Tables ES.2 and ES.3 do not agree. Some ECOs that are shown as not applicable on Table ES.3 are not listed in Table ES.2 (ECO 5 for example). Also ECO 1 is shown as not applicable for some buildings but some parts of ECO 1 (pipe insul.) was applicable.	A - Made corrections to Tables to fix differences in ECOs 1 and 5
5.	pg 3-11	Buildings 40-42 were not simulated. Are they similar to some other buildings? How was the energy savings determined?	A - Clarification added.
6.	pg 3-15	This table shows energy savings for ECO 1 (wall and roof) for buildings 111-126 but the simulation for building 100 which is typical for these buildings does not show any savings.	A - Clarification added to computer simulation summaries Appendix C-20.
7.	pg 3-22	Bldg 114 has a SIR of 0.6 and should not be included.	A - Table corrected.
8.	pg C-5.1	ECO-5 should be evaluated based on 25 years.	A - LCCA corrected.
9.	pg C-7.2	The LCCA sheet was not included.	A - LCCA added for ECO.
10.	pg C-9.2 ECO 9	Document in your assumptions the 0.8 gpm figure used in calculating the pump size.	A - Clarification added.
11.	pg C-10.2	The calculations for ECO 10 is not clear. How was the 5,960,000 Btuh figure derived. I did not see a computer simulation for this building. Please clarify this ECO and clearly state all assumptions made.	A - Sample calculation added. 5,960,000 Btuh figure deleted from calc.
		Volume I of Ft. Gillem study	
12.	pg ES-2	Same as comment #2.	A - Note added Table to indicate measurement only.
13	pg ES-3	Add ECO 5 to buildings 401 and 403 and explain why they are not feasible.	A - ECO 5 added to Table for 401 & 403 with explanation.

PROJECT COMMENTS

Date: 8 Jun 1992 Page 2 of 2

Project: Energy Savings Opp. Survey
Site(s): Ft. McPherson, GA

To: EMC Engineers Inc.
From: EN-DF/Williams

___Foundation Report
___10% Submittal
___Concept Submittal
_X_Interim Submittal
___Preliminary Submittal
___Pre-Final Submittal
___Final Submittal
___VE Study
___Annotated Comments
___Customer Comments
___Correspondence
___Corrected Final

Item	Refer	Comment	Action
14.	pg 3-8	This narrative does not show the buildings that were analyzed at Gillem.	A - Corrected narrative.
15.	pg 3-71	This page indicates no energy savings but the following page indicates saving. Please clarify.	A - Clarification provided.
16.	pg C-5.1	ECO-5 should be evaluated based on 25 years.	A - Revised LCCA for 25 years.
17.	pg C-9.2	Document in your assumptions the 0.8 gpm figure used in calculating the pump size.	A - Clarification added.
18.	pg C-10.2	Where are the calcs for buildings on page C-10.1? This calculation is for a building at McPherson. Please clarify this ECO and clearly state all assumptions made.	A - Sample calculation corrected. Calculation is for a building at Gillem.
19.	pg C-14.5	What are references 4, 5, 6, & 8 mentioned on this page? Where is the sample calculation for this ECO?	A - References provided. Sample calculation added.

PROJECT COMMENTS

Date: 15 June 1992 Page 1 of 1

Project: Energy Savings Opp. Survey
Site(s): Ft. McPherson, GA
FY: 1992
LI: 2006000
CN:

To: ENC Engineers Inc.
Thru: PM-MP/Lindemeier
Thru: EN-D/Lupton
Thru: EN-DF/Hughes
From: EN-DF/Twitty

____Foundation Report
____10% Submittal
____Concept Submittal
X Interim Submittal
____Preliminary Submittal
____Pre-Final Submittal
____Final Submittal
____VE Study
____Annotated Comments
____Customer Comments
____Correspondence
____Corrected Final

Item	Refer	Comment	Action
		Volume I of Ft. McPherson study	
1.	pg 3-36	The total construction cost shown is $172,912. The correct figure should be 162,913. This will change the payback.	A - Revised motor savings and costs. from the manufacturer.
2.	pg 3-69	$220,706 is a lot of money for lighting controls for one building. Is it possible to tie the lighting contols in this building into the existing building DDC system or use occupancy sensors as described on pages 3-63 and 3-64?	A - Revised costs obtained from manufacturer.

Georgia Power Company
Airport District
112 Lake Mirror Road
Forest Park, Georgia 30050
Telephone 404 526-6526

Georgia Power
the southern electric system

June 25, 1992

Ms. Terry R. Seabrook
Department of Army
HQ Fort McPherson
DEH Bldg. 358
Fort McPherson, GA 30330-5000

RE: Energy Savings Opportunity Survey

Dear Ms. Seabrook:

I have reviewed the above referenced material as requested. It is a very thorough report and appears to be technically sound. I would like to examine some of the detailed calculations as time did not permit me to do so.

Below are notes of interest for your review:

°Demand savings may not be realized until billing demand ratchets run their course. INFO ONLY

°All demands on equipment may not be coincident and therefore savings may not be a combination of selected ECO projects. INFO ONLY

°Table 3-26 on page 3-67 has "Billing and Actual Demands" reversed. 3-76 A- PAGE 3-76 THE SAME, NO CHANGE.

As we discussed earlier, opportunity exists to control demand and, to a lesser degree, energy with demand control computerized equipment. We also can look at different rate applications that may benefit Fort Gillem. I have also enclosed a copy of the energy efficiency programs offered by Georgia Power.

If you have questions, please do not hesitate to call me or Gwen Harvey at 362-5546. I look forward to discussing this information on the morning of June 25.

Sincerely,

Herbert Joseph

OJECT Energy Savings Opportunit_ Survey

ST Forts McPherson/Gillem, GA.

DATE 25 June 1992

TIME 1000 Hours

LOCATION DEH Conference Room

Interim Presentation/Review

CONFERENCE PARTICIPANTS

NAME	ORGANIZATION	POSITION	PHONE
Jerry R. Seabrook	DEH	Installation Energy Coor	752-3076
CARL LUNDSTROM	EMC ENGINEERS, INC	PROJECT MANAGER	952 3697
Chris Stanley	EMC ENGINEERS, INC	CO-OP	952-3697
DON HELDT	DEH O&M	Foreman, OPS Branch	669-7163
BUDDY RAPPOLA	D.E.H. F.E.S.D.	MAINTENANCE MECHANIC SUPERVISOR	363-5411
John Rose	GA Power Co	Gov't Sales	526-3569
DENNIS H. LINDEMEIER	USACOE SAVANNAH CESAS-PM-MP	PROJECT MANAGER	912/652-5623
DENISE WILLIAMS	COE SAV DIST	MECH ENGR	912/652-558
V[illegible]ESH KAPUR	FORSCOM ENGR-	MECH ENGR	404-669-6731
HARRY H. FOSTER	DEH O+M		752-2688
Gwen Harvey	GA Power	DIST Rep-GILLEM	362-5449
Herb Joseph	GA Power	DIST Rep-GILLEM	362-5449
JIM MATHIS	DEH	Ch, Engr, Plns & Svc Div.	752-2207

ATE 5411

CONFERENCE PARTICIPANTS

PROJECT: ENERGY SAVINGS OPPORTUNITY SURVEY (ESOS)

CONTRACT NUMBER: DACA21-91-C-0097

LOCATION: FT. MCPHERSON.

PRE-FINAL REV. CONF. ; 21 AUGUST 1992

NAME	POSITION	OFFICE SYMBOL	TELEPHONE
DENNIS H. LINDEMEIER	PROJECT MANAGER	COE, SAVANNAH CESAS-PM-MP	(912) 652-5623 DSN 971-6330 ext. 5623
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BUDDY RAPPOLD	MAINTENANCE MECH. SUPER.	F.E.S.D.	(404) 363-5411
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JIM MATHIS	EP&S	DEH	752-2207
NARESH KAPUR	MECH ENGR	HQ FORSCOM FCEN-RDF	404-669-6731
LTC CARL	McNAIR ~~DEH~~	FT. McPHERSON	752-2161

ATTACHMENT #1

PM UP COPY

1/3

FORSCOM EEAP REVIEW CMTS 8/7/92.

PROJECT: ESOS FORT McPHERSON/ GILLEM. GA.

REVIEWER: NARESH KAPUR. PE, 404-669-6731

FAX [redacted] X 7751

Notes: Comments are for Ft McPherson study. Also applicable to same ECOs at Gillem

ITEM #	PARA PAGE	COMMENT	REVIEW ACTION
1.	GENERAL App. C.; C11.4 → C11.8	During 25 June 92 mtg, A/E agreed to provide Light level readings → Where do we look for info.	NO FURTHER ACTION REQUIRED
2.	ES-4 ES-10/11	Consider over-all cumulative numbers for Const Cost, Annual savings, Annual cost avoidance, PB, SIR. This Table is repeated.	A
		TABLE IS TO BE REVISED TO ADD CUMULATIVE COSTS.	
3.	General	Write a 1 or 2 Page wrap up letter to Garrison Cdr explaining in layman's terms items like ECOs recommended Total Cost, Total savings, Pay Back/ Return on Investment etc. What are the suggested priorities/sequence of accomplishing them. Which ones should be done I/H. This is not for the report but for presentation purpose.	A.
		ADD BEFORE EXECUTIVE SUMMARY	
4.	3.4.1.2 3-17	Pl explain the calculations, especially as associated with fixing the leakage as part of this ECO. Cost Increase in the enclosed Table (pg 3+3) needs to be explained.	A.
		PROVIDE SOME ADDITIONAL ECO DESCRIPTION TO CHAPTER 3	

AUG-07-1992 15:19

THESE INCREASES WERE THE RESULT OF FACTORING IN CONTINGENCIES & DESIGN (APPROX 11%) ATTACHMENT #2

FORSCOM EEAP REVIEW CMT
ESOS FORT MCPHERSON/GILLEM GA
FORSCOM Supr. Mr Kapur 404-669-6731

ITEM #	PARA / PAGE	COMMENT	REVIEW ACTION
5.	3.4.5 / 3-33	PB 13.2. Can you calculate PB based on differential cost basis only. Change Recommendations accordingly. Does this ECO consider if the Motors are Variable speed or Hours of operation?	A
6.	3.4.11 / 3-52	Is there difference in life (hrs) of different light bulbs. Would That result in Non-energy savings (±).	A
7.		CHECK CALCULATION METHODOLOGY (LEAKAGE) TO BE CERTAIN LEAKAGE GOES DOWN (AS CLOSE TO ZERO AS POSSIBLE).	A

• COMMENT IN ECO WRITE-UP TO BE MODIFIED TO REFER READER TO AN APPENDIX FOR OTHER ADDITIONAL DATA

• WILL REVISE CALCULATIONS

3/3

Interim

TABLE 3.10
ECO 1, DUCT INSULATION

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
042	0	5,620	52	71	386	0	0	386	1,584	4.5	4.1
116	0	7,804	72	99	537	0	0	537	2,202	4.5	4.1
105	0	301	3	4	21	0	0	$\boxed{21}$	$\boxed{86}$	4.5	4.1
358	0	7,008	64	88	480	0	0	480	1,975	4.5	4.1

Old

1 12 19.1

3

Prefinal

TABLE 3-10
ECO 1, DUCT INSULATION

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings ($/yr)	Annual Demand Savings ($/yr)	Annual Non-Energy Savings ($/yr)	Total Annual Savings ($/yr)	Const. Cost ($)	SIR	Simple Payback (yrs)
105	0	469	4	5	29	0	0	$\boxed{29}$	$\boxed{104}$	5.7	3.6
116	0	10,385	86	121	665	0	0	665	2,701	5.1	4.1
358	0	9,412	77	110	602	0	0	602	2,426	5.1	4.0
042	0	7,408	61	87	475	0	0	475	1,945	5.0	4.1
118	0	1,982	15	22	122	0	0	122	2,449	1.0	20.1

8/7/92

New

New

S: 3Aug 92 / Hennessy

PROJECT REVIEW COMMENTS		Date: 29 July 1992	Page of
TO: SEABROOK	FROM: (Section) O&M (Reviewer) HELDT		
Project: Energy Savings Opportunity Survey Location: Fort McPherson, GA.		Year: FY-92	Line Item No.: -

Type of Action: (Check appropriate boxes) ☐ Preliminary ☐ Final ☐ ☐ Paving & Grading ☐ Architectural ☐ Structural ☐ Mechanical ☐ Electrical ☐ Sanitary

Item No.	Drawing No. or Par. No.	COMMENTS	REVIEW ACTION*
1	Appendix 8, Interim Submittal Pg 2 of 8	Item # 13 – Errors Have Not Been Corrected • VOLTAGES WILL BE CORRECTED. • EFFICIENCIES OF VARIABLE SPEED MOTORS WILL ALSO BE ADDRESSED IN GREATER DETAIL	A

AFZK-EH Form 129, 1 Apr 82

* A-E to fill in the review action on the reproducible copy and return to Post.

PROJECT COMMENTS | Date: 3 Aug 1992 | Page 1 of 1

Project: Energy Savings Opp. Survey
Site(s): Ft. McPherson, GA
FY: 1992
LI: 2006000
CN:

To: EMC Engineers Inc.
Thru: PM-MP/Lindemeier
Thru: EN-D/Lupton
Thru: EN-DF/Hughes
From: EN-DF/Williams

___Foundation Report
___10% Submittal
___Concept Submittal
___Interim Submittal
___Preliminary Submittal
_X_Pre-Final Submittal
___Final Submittal
___VE Study
___Annotated Comments
___Customer Comments
___Correspondence
___Corrected Final

Item	Refer	Comment	Action
		Ft. Gillem Study NO SIMULATION, ~~SAMPLE~~ CALCULATION WAS USED.	
1.	pg C.14.2.1A	This page indicates that the energy savings were from a simulation for Bldg 207. Where is the sample ~~calculation~~ using the equations on page C.14.2.3? How were the factors BLC and G, shown on page C.14.2.3 derived?	A TEXT WILL BE REVISED TO IMPROVE CLARITY.
2.	pg ES-2	Add measurement only to ECO 4 of the separately bound Executive Summary and Volume I.	A
3.	pg 4-1	Why wasn't ECO-1, Roof Insulation included in any of the projects. THERE IS AN ECO FOR 1 BLDG ONLY & THIS WILL BE INCL. W/ AS AN MCA PROJECT.	A

APPENDIX B

UTILITY RATES AND HISTORICAL USAGE CALCULATIONS

GEORGIA POWER COMPANY

Full Use Service to Governmental Institutions

SCHEDULE "G-10"

AVAILABILITY:

Throughout the Company's service area from existing lines of adequate capacity, except that service under this tariff is not available to a customer who is served from an underground network system or who applies for service after December 29, 1981 at a service level below 12 kV.

APPLICABILITY:

Full use service to large Federal, State, and Municipal agencies and Institutions at a single delivery point through a single meter. This schedule is not applicable to Housing Projects or other Governmental agencies or Institutions whose service requirements are predominantly residential, nor is it available to any customer who has more than one meter per structure.

TYPE OF SERVICE:

Single or three phase, 60 hertz, at a standard voltage.

MONTHLY RATE - Energy Charge Including Demand Charge:

Base Charge $55.00

All consumption (kWh) not greater than 300 hours times the billing demand:

First 50,000 kWh	**@**	**6.00¢ per kWh**
Next 150,000 kWh	**@**	**5.82¢ per kWh**
Next 800,000 kWh	**@**	**4.42¢ per kWh**
Over 1,000,000 kWh	**@**	**4.10¢ per kWh**

All consumption (kWh) in excess of 300 hours times the billing demand .... @ .... 1.15¢ per kWh

Minimum Monthly Bill:

$55.00 Base Charge plus $8.00 per kW of Billing Demand, but not less than $3,400.00 per month, plus excess kVAR charges and Fuel Cost Recovery as applied to the current month kWh.

FUEL COST RECOVERY:

The amount calculated at the above rate will be increased under the provisions of the Company's effective Fuel Cost Recovery Schedule, including any applicable adjustments.

DETERMINATION OF BILLING DEMAND:

The Billing Demand shall be based on the highest 30-minute kW measurement during the current month and the preceding eleven (11) months.

For the billing months of **June** through **September**, the Billing Demand shall be the greatest of:

(1) The current actual demand, or,
(2) Ninety-Five percent (95%) of the highest actual demand occurring in any previous applicable summer month (June through September), or,
(3) Sixty percent (60%) of the highest actual demand occurring in any previous applicable winter month (October through May).

For the billing months of **October** through **May**, the Billing Demand shall be the greater of:
(1) Ninety-Five percent (95%) of the highest summer month (June through September), or,
(2) Sixty percent (60%) of the highest winter month (October through May), including the current month.

In no case shall the Billing Demand be less than the greatest of:
(1) The contract minimum, or,
(2) Fifty percent (50%) of the total contract capacity, or,
(3) 3,000 kW for any customer applying for service under this rate subsequent to December 22, 1971, or,
(4) 6,000 kW for any customer applying for service under this rate subsequent to December 29, 1981.

Where there is an indiction of a power factor of less than 95% lagging, the Company may, at its option, install metering equipment to measure Reactive Demand. The Reactive Demand shall be the highest 30-minute kVAR measured during the month. The Excess Reactive Demand shall be kVAR which is in excess of one-third of the measured actual kW in the current month. The Company will bill excess kVAR at the rate of $0.27 per excess kVAR.

TERM OF CONTRACT:

Not less than one year.

REVENUE ADJUSTMENT:

The bill calculated at the above rate is subject to change in such an amount as may be determined under the provisions of the Company's Revenue Adjustment Rider, Schedule "RA-1", as approved by the Georgia Public Service Commission or as may be later amended.

Service hereunder subject to Rules and Regulations for Electric Service on file with the Georgia Public Service Commission.

ATLANTA GAS LIGHT COMPANY

LARGE COMMERCIAL INTERRUPTIBLE SERVICE RATE I-24

Territory:

In the natural gas service areas of the Company as shown on the current Rate Zone Map on file with the Georgia Public Service Commission.

Available:

On Special Contract to any regular natural gas customer on an interruptible basis for commercial purposes whose normal productive uses of gas require a consumption of 1,000 therms or more of gas in any one day in the territory shown above, and who contracts in writing for service under this schedule for substantially all of his fuel requirements that the Company can supply, provided the Company has gas delivery capacity in excess of the then existing requirements of other customers and provided the Company has available to it from its suppliers at the delivery point nearest to the customer an adequate supply of natural gas to meet the customer's requirements. The Company reserves the right to refuse (a) to contract for Firm Use Gas, or (b) to make gas available where the relationship between the average daily consumption and the maximum daily consumption indicates a forced or unusual usage on the maximum day in an attempt to qualify for the minimum daily consumption stated above.

Character of Service:

1. All gas delivered under this rate schedule shall be subject to curtailment in whole or in part only after the Company has given at least thirty minutes notice by telephone or otherwise except in force majeure conditions. The Company may curtail customers served under this rate schedule in such order and each customer to such extent as the Company deems necessary for the proper operation of its distribution systems. Upon notice of curtailment by the Company in whole or in part of the supply of gas to the customer, the customer must promptly discontinue use of gas in whole or in part as provided in the curtailment notice.

2. Interruptible service may be curtailed at any time after notice as provided in (1) above.

3. Firm Use gas as hereinafter defined will not be curtailed except pursuant to the Company's load control provisions filed with and approved by the Georgia Public Service Commission from time to time.

Effective:
With service on and after
February 1, 1992

ATLANTA GAS LIGHT COMPANY

LARGE COMMERCIAL INTERRUPTIBLE SERVICE RATE I-24

Rate:

Customer Charge:

The monthly customer charge shall be based upon the maximum use occurring in the current month or the prior eleven months as follows:

Maximum monthly use	Monthly Charge
Under 30,000 therms	$ 300
30,000 to 49,999 therms	375
50,000 to 99,999 therms	475
100,000 to 249,999 therms	800
250,000 to 499,999 therms	1,000
500,000 to 999,999 therms	2,000
1,000,000 to 2,999,999 therms	4,500
3,000,000 to 7,500,000 therms	11,000
Over 7,500,000 therms	18,000

Firm Use Charge:

For the quantity of natural gas stated in the contract for service as the Firm Use per day at $15.60 per therm per year billed at $1.30 per therm per month.

Commodity Charge:	Monthly Rate Per Therm Net
First 100,000 therms used per month	7.0 cents
Next 200,000 therms used per month	5.7 cents
Over 300,000 therms used per month	4.7 cents

Summer Air-Conditioning Rate:

For any customer who qualifies for service under this rate schedule who has installed and regularly operates a gas-fired central air conditioning system which meets Company's specifications and which equipment consumes more than 50% of the total gas used during the seven-month period April through October inclusive, all gas used during such period, in excess of 4,000 therms per month, will be billed at 3.5 cents per therm.

Firm Use:

Firm Use is the daily rate of taking of gas in therms agreed upon in writing as the maximum rate of delivery which the Company shall be required to make to the customer in any one

Effective:
With service on and after
February 1, 1992

ATLANTA GAS LIGHT COMPANY

LARGE COMMERCIAL INTERRUPTIBLE SERVICE RATE I-24

Firm Use (cont'd)

day during any period when the Company's supply of natural gas, in the opinion of the Company, is inadequate to supply the total requirements of all its customers supplied from the delivery point from which the customer is supplied. The hourly rate of delivery of Firm Use Gas shall not be greater than 1/18th of the Firm Use per day contracted for. Except in cases of force majeure as defined herein, in the Company fails to deliver for a period of more than 24 continuous hours in any month the amount of the daily firm quantity contracted for, the firm use charge for that month shall be prorated on a daily basis.

Unauthorized Consumption of Gas:

In the event the customer fails to comply with any curtailment order of the Company reducing either the customer's hourly or daily use of gas, the Company may elect one of the following options:

(A) To discontinue completely all deliveries to the customer, including any Firm Gas under contract, during the day customer fails to comply with such curtailment order; or

(B) To furnish such quantity of overrun gas as the Company, in its judgment determines it can supply, at a surcharge of 50.0 cents per therm in addition to the regular commodity charge for such gas, subject however to discontinuance at any time by the Company at its election.

(C) To require Customer to pay Company a charge of $3.00 per therm for all unauthorized gas taken, not supplied by Company pursuant to (B) above, in addition to the regular commodity charge for such gas.

Determination of Therms:

The gas for any billing period, expressed in hundreds of cubic feet shall be multiplied by the average BTU of the gas send-out as determined below and divided by 1,000 in order to determine the number of therms consumed for billing purposes. Such calculation shall be made to the nearest whole therm.

Effective:
With service on and after
February 1, 1992

A T L A N T A   G A S   L I G H T   C O M P A N Y

LARGE COMMERCIAL INTERRUPTIBLE SERVICE **RATE I-24**

Determination of Therms (cont'd)

The average BTU of the gas send-out for billing purposes shall be calculated for each calendar month from the weighted average BTU of natural gas delivered to the Company in the city or area where the customer receives service by the Company's suppliers and from the gas delivered by the Company in such city or area from its standby plants, as determined by appropriate calorimeters operated by the Company or its suppliers.

Minimum Monthly Bill For Firm Service:

The minimum monthly bill for firm service shall be the monthly billing.

Minimum Annual Guaranteed Bill For Interruptible Service:

All customers who receive or contract for interruptible service under this rate schedule whose annual bill for volumes of interruptible gas actually consumed is less than $6,000 shall pay a deficiency payment not to exceed $1,000. This deficiency payment shall be equal to $1,000 times a fraction whose numerator is $6,000 less the actual bill for interruptible service and whose denominator is $6,000. The customer's minimum annual guaranteed bill for interruptible service shall be based upon the volumes of interruptible gas consumed between August 1 and the following July 31. No minimum annual guaranteed bill obligation for interruptible service shall be effective for contracts which on July 31 have been in effect less than twelve months.

Payment:

Bills are due when rendered at the net rate shown above and shall be paid in full at any office of the Company within ten (10) days from the date mailed or otherwise delivered.

Terms of Service:

1. Company may supply gas from any standby or synthetic source, provided that the gas so supplied shall be reasonably equivalent on a BTU basis to the natural gas normally supplied hereunder.

2. Contract for service shall be in writing and specify in writing the daily and hourly rates of consumption and shall be for a minimum period of one year.

Effective:
With service on and after
February 1, 1992

ATLANTA GAS LIGHT COMPANY

LARGE COMMERCIAL INTERRUPTIBLE SERVICE RATE I-24

Terms of Service (cont'd)

3. The amount of

(a) any sales, gross receipts, franchise, excise, privilege, occupation or other tax or charge whether imposed by statute, ordinance, or franchise contract, that the Company pays to any governmental body, based on, or determined by, the sale of gas hereunder; and

(b) any charge paid by the Company to any gas supplier as a result of any sales, excise, gross receipts, or other taxes, license fee, or governmental charges imposed upon such supplier, based on, or determined by, the production, severance, manufacture, transportation or sale of gas hereunder, shall be added to and become a part of the charges to the customer under this rate schedule. Provided however, if any additional payments are imposed upon the customer by reason of this clause, the customer may, by thirty days notice in writing to the Company, cancel his contract and discontinue the use of natural gas service under this rate schedule.

4. When gas is delivered at a pressure in excess of 14.73 pounds per square inch absolute, then for the purpose of measurement hereunder, such volumes of gas shall be corrected to a pressure of 14.73 pounds per square inch absolute. It is assumed that the atmospheric pressure is 14.4 pounds per square inch. The measurement of gas volumes shall be adjusted for deviation from Boyle's Law in accordance with generally accepted engineering practice; provided, however, that where gas is delivered through positive displacement meters at a pressure not in excess of 20 pounds per square inch gauge, the gas shall be assumed to obey Boyle's Law.

5. Where orifice meters are used, volumes delivered shall be computed in accordance with formulae, tables and methods prescribed in Orifice Metering of Natural Gas, Gas Measurement Committee Report No. 3 of the American Gas Association published April, 1955, reprinted with

Effective:
With service on and after
February 1, 1992

A T L A N T A   G A S   L I G H T   C O M P A N Y

LARGE COMMERCIAL INTERRUPTIBLE SERVICE RATE I-24

Terms of Service (cont'd)

5. (cont'd)
revisions in January, 1956. Said volumes shall be corrected for daily average flowing temperature from 60°F and specific gravity.

Where rotary or turbine type meters are used on installations where customer's annual usage is more than 3,000,000 therms, all volumes measured by such meters shall be corrected to a base temperature of 60°F.

6. Gas purchased under this rate shall not be resold by the purchaser thereof in any manner, and the Company will discontinue service upon notice to the Customer, when it is determined that gas is being resold in violation of this provision of the rate schedule, in the event the Customer does not immediately discontinue such resale after such notice.

7. In the event either Company or its suppliers or the Customer is unable, wholly or in part, by reason of force majeure to carry out its obligations, other than to make payments for gas received, it is agreed that on giving notice of such force majeure as soon as possible after the occurrence of the cause relied on, the obligations of the Company or the Customer so far as they are affected by such force majeure, shall be suspended during the continuance of any inability so caused but for no longer period, and such cause shall as far as possible be remedied with all reasonable dispatch.

8. The term "force majeure" as employed above shall mean acts of God, strikes, lockouts, or other industrial disturbances, acts of the public enemy, war, blockades, insurrections, riots, epidemics, landslides, lightning, earthquakes, fires, storms, floods, washouts, arrests, and restraints of governments and people, civil disturbances, explosions, breakage or accident to machinery or lines of pipe, exhaustion or depletion of the Company's stocks of peak shaving fuel, exhaustion or depletion of the Company's supply of underground storage gas, freezing of wells or lines of pipe,

Effective:
With service on and after
February 1, 1992

ATLANTA GAS LIGHT COMPANY

LARGE COMMERCIAL INTERRUPTIBLE SERVICE — RATE I-24

Terms of Service (cont'd)

8. (cont'd)
partial or complete curtailment of deliveries to Company's suppliers as a result of force majeure under the suppliers' gas purchase contracts, inability to obtain rights-of-way or permits or materials, equipment or supplies, and any other causes, whether of the kind herein enumerated or otherwise, not within the control of the Company or its suppliers or the Customer and which by the exercise of due diligence either the Company or its suppliers or the Customer is unable to prevent or overcome. It is understood and agreed that the settlement of strikes or lockouts shall be entirely within the discretion of the person affected and the above requirement that any force majeure shall be remedied with all reasonable dispatch shall not require the settlement of strikes or lockouts when such course is inadvisable in the discretion of the person affected thereby.

9. A day, as used herein, is defined as a period of 24 consecutive hours, beginning at 8:00 a.m. Standard Time.

10. A month, as used herein, is defined as the period beginning on the first day of the calendar month and ending on the first day of the next succeeding calendar month.

Additional Terms and Provisions:

Service under this schedule is subject to the Terms of Service and Rules and Regulations of the Company, as filed with and approved by the Georgia Public Service Commission from time to time, as well as all future riders and tariff provisions made applicable to service under this schedule by the Georgia Public Service Commission from time to time, including without limitation, the Load Control Provisions, Purchased Gas Adjustment Rider, Franchise Recovery Rider and Direct Bill Take-or-Pay Gas Cost Recovery Rider.

Effective:
With service on and after
February 1, 1992

M.A.I.S. MONTHLY BILLING INVOICE DATA
FEBRUARY 1992

ACCOUNT 23088 2300 1 2 U S ARMY - FT. MCPHE
FORT MCPHERSON

METER NUMBER 440545 — GAS USED - MCF 10,284

TOTAL MCF PASSED THRU METERS 10,284

NET MCF USED 10,284

AVG BTU 1026 X NET MCF 10,284 DIVIDED BY 100 = 105,514.0 THERMS

RATE I-24 CODE 33700 DIST 1210180		THERMS	CENTS/THERM	NET AMOUNT
MONTHLY CUSTOMER CHARGE (BASED ON 12/91 USAGE OF 131,461.0 THERMS)				800.00
DAILY FIRM CONTRACT	6,000	6,000.0	130.000	7,800.00
PGA ON DEL FRM		105,514.0	37.88	39,968.70
COMMODITY CHARGE FIRM THERMS		100,000.0	7.0000	7,000.00
COMMODITY CHARGE FIRM THERMS		5,514.0	5.7000	314.30
PGA ON INTERRUPT (COMMOD - FIRM)		.0	22.64	.00
BASE TAKE OR PAY COST		105,514.0	.6700	706.94
TOTAL				56,589.94
FRAN. REC. FACTOR(47,768.70 X .0122)				582.78
0 % SALES TAX				.00
TOTAL CURRENT AMOUNT				57,172.72

SAMPLE BILLING FROM ATLANTA GAS LIGHT

UNIT ENERGY COSTS

EMC PROJECT:	#3105.000
DATE:	07/17/92
FILE:	NRGCOST.WK3
PRPARED BY:	DENNIS JONES
CHECKED BY:	

NATURAL GAS – MONTHLY CHARGES

MONTHLY CUSTOMER CHARGE	$250	
FIRM USE CHARGE	$1.300 PER THERM	
FORT McPHERSON	$7,800	6,000 THERMS
FORT GILLEM	$10,400	8,000 THERMS

CONSUMPTION: MONTHLY METER READING (MCF) X 10.29 THERMS/MCF = THERMS

COST OF FIRST 100,000 THERMS	$0.070 PER THERM
COST OF NEXT 200,000 THERMS	$0.057 PER THERM
COST OF OVER 300,000 THERMS	$0.047 PER THERM

GAS ADJUSTMENT (FIRM): $0.397 PER THERM 91/92 AVERAGE
(SEE GAS RATE ANALYSIS)
INCREMENTAL GAS COST SAVINGS:

THE GAS ADJUSTMENT DOMINATES GAS COSTS	$0.397 PER THERM
MOST GAS USAGE IS IN THE 100,000 THERM BLOCK	$0.070 PER THERM
RESULTING INCREMENTAL GAS COST IS	$0.467 PER THERM
RESULTING INCREMENTAL GAS ENERGY COST IS	$4.670 PER MBTU

ELECTRICITY – MONTHLY CHARGES

BASE CHARGE $55

CONSUMPTION:

KWH LESS THAN 300 X BILLING DEMAND

COST OF FIRST 50,000 KWH	$0.0600 PER KWH
COST OF NEXT 150,000 KWH	$0.0582 PER KWH
COST OF NEXT 800,000 KWH	$0.0442 PER KWH
COST OF OVER 1,000,000 KWH	$0.0410 PER KWH

KWH MORE THAN 300 X BILLING DEMAND
$0.0115 PER KWH

BILLING DEMAND IS GREATEST OF:
(1) CURRENT MONTHLY ACTUAL DEMAND
(2) 95% OF HIGHEST DEMAND IN PREVIOUS JUNE THRU SEPTEMBER
(3) 60% OF HIGHEST DEMAND IN PREVIOUS OCTOBER THRU MAY

POWER FACTOR CHARGE:
POWER FACTOR < 95% $0.27 PER KVAR

FUEL COST RECOVERY:
$0.0140 PER KWH

MINIMUM MONTHLY BILL:
$55 BASE CHARGE + $8.00 PER KW OF BILLING DEMAND
BUT NOT LESS THAN $3,400
PLUS POWER FACTOR CHARGE AND FUEL COST RECOVERY

INCREMENTAL ELECTRIC COST SAVINGS:
($0.0410–$0.0115)*300=$8.85
$0.0115+$0.0140=$0.0255

NO SAVINGS FOR REDUCTION IN MONTHLY DEMAND
$8.85/KW SAVINGS FOR REDUCTION IN ANNUAL PEAK DEMAND
$0.0255/KWH SAVINGS FOR REDUCTION IN USAGE

WATER–MONTHLY CHARGES

CHARGE:
COST OF FIRST 3 CCF (BASE CHARGE) $3.35
COST OF NEXT 067 CCF AT $1.70 PER CCF
COST OF NEXT 600 CCF AT $1.04 PER CCF
COST OF OVER 670 CCF AT $0.72 PER CCF

SEWAGE–MONTHLY CHARGES

BASE CHARGE:
WATER CONSUMPTION TIMES 89%, AT $1.20 CCF

INCREMENTAL WATER SEWAGE SAVINGS:
$0.72 CCF X 1/748.05 GAL PER CCF X 1000= $0.96 PER THOUSAND GALLONS
PLUS
$1.20 X 1/748.05 X 1000 X 0.89= $1.43

RESULTING INCREMENTAL WATER/SEWAGE COST IS
0.96+1.43=$2.39 PER THOUSAND GALLONS

748.05 GALLONS/CCF

HISTORICAL UTILITY USAGE

E M C ENGINEERS, INC.
PROJECT: .FORT McPHERSON & FORT GILLEM ESOS STUDY

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 04/22/92
FILE: ENERGY.WK3
PRPARED BY: DENNIS JONES
CHECKED BY:

	FORT MCPHERSON										BLDG 200	
DATE	ELECTRIC USAGE (KWH)	ELECTRIC DEMAND (KW)	BILLING DEMAND (KW)	ELECTRIC COST ($)	NAT GAS USAGE (THERMS)	NAT GAS COST ($)	WATER COST ($)	WATER USAGE (GAL)	SEWAGE COST ($)	SEWAGE USAGE (GAL)	ELECTRIC USAGE (KWH)	ELECTRIC COST ($)
FY90												
OCT	2,966,400	6,626	7,710	149,348	40,565	35,980	7,171	6,965,094	11,173	6,965,094	1,163,200	
NOV	2,512,800	5,924	7,710	137,565	69,750	50,228	6,303	6,000,858	9,626	6,000,858	1,328,800	66,901
DEC	3,081,600	6,669	7,710	153,222	128,769	78,564	6,554	6,332,244	10,038	6,332,244	1,206,400	66,045
JAN	3,441,600	6,993	7,710	162,924	147,128	88,306	5,482	5,165,286	8,286	5,165,286	1,155,200	57,438
FEB	2,577,600	5,913	7,710	137,835	113,588	62,853	5,871	5,524,350	8,862	5,524,350	1,207,200	57,149
MAR	2,937,600	6,210	7,710	149,341	93,751	53,309	6,195	5,781,678	8,929	5,781,678	1,044,000	55,827
APR	2,620,800	5,659	7,710	140,804	57,239	34,191	6,778	6,511,027	6,734	6,511,027	1,046,400	53,197
MAY	3,088,800	6,988	7,710	153,230	19,608	16,967	7,102	6,790,050	10,892	6,790,050	1,128,000	60,602
JUN	3,686,400	8,041	8,041	172,113	15,426	15,192	7,858	7,489,477	12,014	7,489,477	1,188,800	58,974
JUL	3,801,600	8,019	8,019	175,028	14,101	14,555	8,982	8,809,037	14,131	8,809,037	1,163,200	54,308
AUG	4,471,200	8,089	8,089	193,630	13,957	14,463	8,268	8,013,860	12,856	8,013,860	1,269,600	58,453
SEP	3,672,000	8,062	8,062	171,891	15,100	14,948	6,799	6,411,537	10,285	6,411,537	1,590,400	68,874
TOTAL	38,858,400			1,896,931	728,982	479,556	83,363	79,794,498	123,826	79,794,498	14,491,200	657,768
FY91												
OCT	3,290,400	6,750	7,685	162,378	33,899	24,064	6,439	6,021,803	9,660	5,379,976	1,298,400	60,780
NOV	2,937,600	5,557	7,685	152,355	71,820	34,833	5,928	5,483,207	8,796	4,899,803	1,262,400	62,298
DEC	2,865,600	5,708	7,685	147,911	117,323	63,723	5,712	5,258,792	8,436	4,700,073	1,217,600	63,149
JAN	2,844,000	6,377	7,685	147,326	163,007	85,670	5,223	4,752,362	7,624	4,249,515	1,152,800	59,503
FEB	2,844,000	6,064	7,685	147,456	122,905	65,613	5,751	5,353,794	8,588	4,790,632	1,295,200	67,094
MAR	2,671,200	5,627	7,685	142,772	99,507	54,511	4,092	3,594,380	5,766	3,220,804	1,100,000	57,033
APR	3,110,400	5,897	7,685	154,677	30,242	22,701	5,912	5,497,419	8,819	4,915,907	1,315,200	70,296
MAY	3,038,400	7,182	7,685	152,909	16,032	15,165	6,153	5,739,039	9,206	5,129,879	1,113,600	55,378
JUN	3,513,600	7,749	7,749	166,351	13,597	13,980	6,951	6,496,815	10,422	5,796,565	1,274,400	64,135
JUL	4,226,400	8,062	8,062	179,619	12,819	13,628	6,238	5,657,502	9,076	5,038,715	1,449,600	68,631
AUG	4,226,400	8,176	8,176	180,590	13,479	13,894	7,354	6,966,590	9,978	6,220,260	1,240,800	52,733
SEP	3,607,200	7,906	7,906	162,767	13,974	14,214	6,835	6,416,773	9,192	5,729,689	993,600	42,456
TOTAL	39,175,200			1,897,111	708,604	421,996	72,588	67,238,476	105,563	60,071,818	14,713,600	723,486
91/92 AVG												
OCT	3,128,400	6,688	7,698	155,863	37,232	30,022	6,805	6,493,449	10,417	6,172,535	1,230,800	30,390
NOV	2,725,200	5,741	7,698	144,960	70,785	42,531	6,116	5,742,033	9,211	5,450,331	1,295,600	64,600
DEC	2,973,600	6,189	7,698	150,567	123,046	71,144	6,133	5,795,518	9,237	5,516,159	1,212,000	64,597
JAN	3,142,800	6,685	7,698	155,125	155,068	86,988	5,353	4,958,824	7,955	4,707,401	1,154,000	58,471
FEB	2,710,800	5,989	7,698	142,646	118,247	64,233	5,811	5,439,072	8,725	5,157,491	1,251,200	62,122
MAR	2,804,400	5,919	7,698	146,057	96,629	53,910	5,144	4,688,029	7,348	4,501,241	1,072,000	56,430
APR	2,865,600	5,778	7,698	147,741	43,741	28,446	6,345	6,004,223	7,777	5,713,467	1,180,800	61,747
MAY	3,063,600	7,085	7,698	153,070	17,820	16,066	6,628	6,264,545	10,049	5,959,965	1,120,800	57,990
JUN	3,600,000	7,895	7,895	169,232	14,512	14,586	7,405	6,993,146	11,218	6,643,021	1,231,600	61,555
JUL	4,014,000	8,041	8,041	177,324	13,460	14,092	7,610	7,233,270	11,604	6,923,876	1,306,400	61,470
AUG	4,348,800	8,133	8,133	187,110	13,718	14,179	7,811	7,490,225	11,417	7,117,060	1,255,200	55,593
SEP	3,639,600	7,984	7,984	167,329	14,537	14,581	6,817	6,414,155	9,739	6,070,613	1,292,000	55,665
TOTAL	12,002,400			531,763	41,715	42,851	22,238	21,137,650	32,759	20,111,549	3,853,600	172,728

ELECTRICITY RATE ANALYSIS

EMC PROJECT: #3105.000
DATE: 04/22/92
FILE: NRGCOST.WK3
PRPARED BY: DENNIS JONES
CHECKED BY:

FORT MCPHERSON

MONTH	ELECTRIC USAGE (KWH)	ELECTRIC DEMAND (KW)	BILLING DEMAND (KW)	ELECTRIC COST ($)	300 X DEMAND (KWH)	FIRST 1,000,000 ($)	UP TO 300 X ($)	OVER 300 X ($)	TOTAL KWH ($)	FUEL ADJUST ($)	FUEL ADJ RATE ($/KWH)
OCT	3,128,400	6,688	7,698	155,863	2,309,250	47,090	53,679	9,420	110,189	45,674	0.0146
NOV	2,725,200	5,741	7,698	144,960	2,309,250	47,090	53,679	4,783	105,553	39,407	0.0145
DEC	2,973,600	6,189	7,698	150,567	2,309,250	47,090	53,679	7,640	108,409	42,157	0.0142
JAN	3,142,800	6,685	7,698	155,125	2,309,250	47,090	53,679	9,586	110,355	44,770	0.0142
FEB	2,710,800	5,989	7,698	142,646	2,309,250	47,090	53,679	4,618	105,387	37,258	0.0137
MAR	2,804,400	5,919	7,698	146,057	2,309,250	47,090	53,679	5,694	106,463	39,593	0.0141
APR	2,865,600	5,778	7,698	147,741	2,309,250	47,090	53,679	6,398	107,167	40,573	0.0142
MAY	3,063,600	7,085	7,698	153,070	2,309,250	47,090	53,679	8,675	109,444	43,625	0.0142
JUN	3,600,000	7,895	7,895	169,232	2,368,500	47,090	56,109	14,162	117,361	51,871	0.0144
JUL	4,014,000	8,041	8,041	177,324	2,412,150	47,090	57,898	18,421	123,409	53,914	0.0134
AUG	4,348,800	8,133	8,133	187,110	2,439,750	47,090	59,030	21,954	128,074	59,036	0.0136
SEP	3,639,600	7,984	7,984	167,329	2,395,200	47,090	57,203	14,311	118,604	48,725	0.0134
TOTAL	39,016,800	6,844	7,803	1,897,021		565,080	659,674	125,663	1,350,416	546,605	0.0140

GAS RATE ANALYSIS – FORT McPHERSON

EMC PROJE#3105.000
DATE: 04/22/92
FILE: NRGCOST.WK3
PRPARED BDENNIS JONES
CHECKED BY:

MONTH	FORT MCPHERSON NAT GAS USAGE (THERMS)	NAT GAS COST ($)	FIRM USE CHARGE ($)	FIRST 100,000 ($)	NEXT 200,000 ($)	OVER 300,000 ($)	GAS ADJUST ($)	ADJUST RATE ($/THERM)	DAILY USAGE (THERMS)
OCT	37,232	$30,022	$7,800	$2,718	$0	$0	$19,254	0.5171	1,201
NOV	70,785	$42,531	$7,800	$5,167	$0	$0	$29,313	0.4141	2,360
DEC	123,046	$71,144	$7,800	$7,300	$1,452	$0	$54,342	0.4416	3,969
JAN	155,068	$86,988	$7,800	$7,300	$3,469	$0	$68,169	0.4396	5,002
FEB	118,247	$64,233	$7,800	$7,300	$1,150	$0	$47,733	0.4037	4,223
MAR	96,629	$53,910	$7,800	$7,054	$0	$0	$38,806	0.4016	3,117
APR	43,741	$28,446	$7,800	$3,193	$0	$0	$17,203	0.3933	1,458
MAY	17,820	$16,066	$7,800	$1,301	$0	$0	$6,715	0.3768	575
JUN	14,512	$14,586	$7,800	$1,059	$0	$0	$5,477	0.3774	484
JUL	13,460	$14,092	$7,800	$983	$0	$0	$5,059	0.3758	434
AUG	13,718	$14,179	$7,800	$1,001	$0	$0	$5,127	0.3737	443
SEP	14,537	$14,581	$7,800	$1,061	$0	$0	$5,470	0.3763	485
TOTAL	718,793	$450,776	$93,600	$45,438	$6,071	$0	$302,668	0.4076	1979

EMC PROJECT: #3105.000
DATE: 02/24/92
FILE: ENERGY.WK3
PRPARED BY: DENNIS JONES
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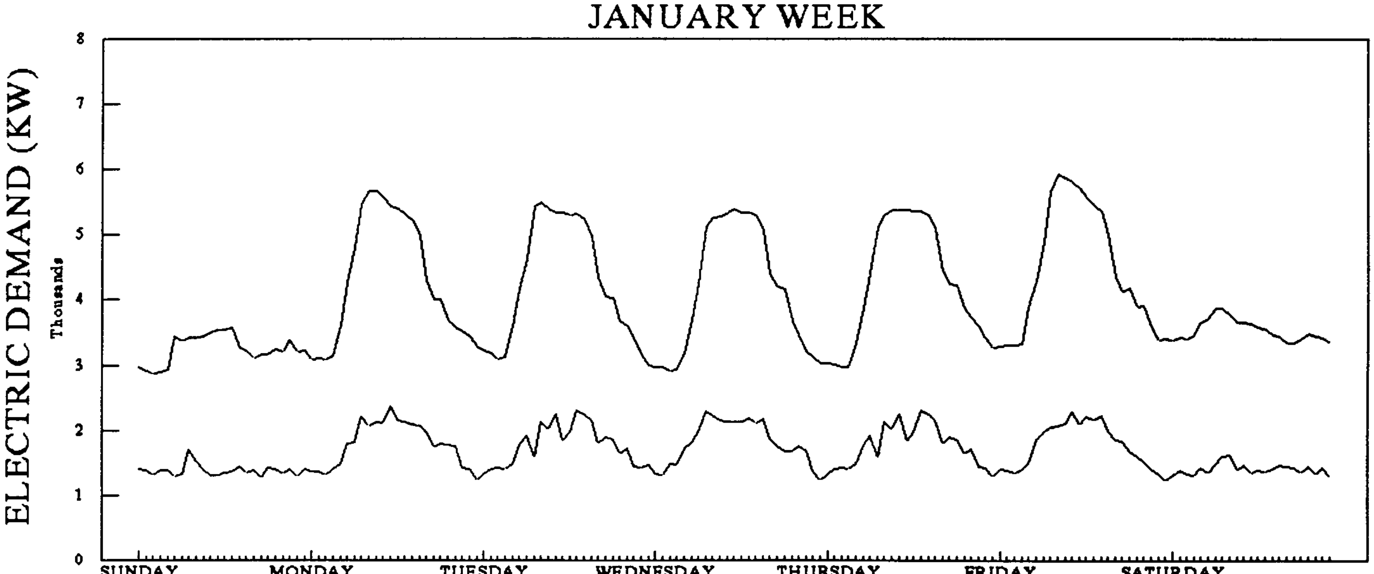
BUILDING-200 EMCS PRINTOUT - JANUARY 1992

UTILITY DATA
FORT McPHERSON

DAY OF WEEK	DECIMAL TIME	OA TEMP (F)	HW TEMP (F)	BLDG 1 DEMAND (KW)	BLDG 2 DEMAND (KW)	DECIMAL TIME	TOTAL DEMAND (KW)	JANUARY DEMAND (KW)	JULY DEMAND (KW)
SATURDAY	1.0	33.3	137.9	490.5	828.0	145.0	1318.5	3,386	4,234
	2.0	32.8	137.6	490.5	891.0	146.0	1381.5	3,413	4,180
	3.0	31.1	137.6	490.5	846.0	147.0	1336.5	3,397	4,115
	4.0	30.5	137.2	495.0	823.5	148.0	1318.5	3,467	4,180
	5.0	29.8	137.2	526.5	895.5	149.0	1422.0	3,650	4,633
	6.0	28.6	136.6	499.5	841.5	150.0	1341.0	3,710	4,687
	7.0	28.4	136.3	544.5	940.5	151.0	1485.0	3,866	4,833
	8.0	28.2	137.1	715.5	900.0	152.0	1615.5	3,872	5,152
	9.0	29.9	137.2	711.0	909.0	153.0	1620.0	3,769	5,357
	10.0	33.6	137.7	531.0	855.0	154.0	1386.0	3,656	5,589
	11.0	38.0	138.0	585.0	882.0	155.0	1467.0	3,650	5,708
	12.0	42.0	138.6	540.0	819.0	156.0	1359.0	3,629	5,810
	13.0	46.2	138.9	540.0	846.0	157.0	1386.0	3,569	5,368
	14.0	49.0	139.2	535.5	837.0	158.0	1372.5	3,559	5,346
	15.0	50.9	139.2	553.5	859.5	159.0	1413.0	3,461	5,351
	16.0	52.0	139.5	594.0	882.0	160.0	1476.0	3,445	5,314
	17.0	53.7	139.4	576.0	882.0	161.0	1458.0	3,353	5,243
	18.0	52.4	139.1	580.5	855.0	162.0	1435.5	3,348	5,076
	19.0	50.4	139.7	522.0	819.0	163.0	1341.0	3,402	4,963
	20.0	49.2	139.1	558.0	900.0	164.0	1458.0	3,472	4,936
	21.0	49.1	138.8	490.5	832.5	165.0	1323.0	3,451	4,925
	22.0	48.5	138.5	522.0	900.0	166.0	1422.0	3,424	4,709
	23.0	47.3	138.7	490.5	810.0	167.0	1300.5	3,337	4,487

FORT McPHERSON ELECTRIC DEMAND

JANUARY WEEK



___ BUILDING-200 ___ FORT MCPHERSON

EMC PROJECT: #3105.000
DATE: 02/24/92
FILE: ENERGY.WK3
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UTILITY DATA
FORT McPHERSON

BUILDING-200 EMCS PRINTOUT - JANUARY 1992

DAY OF WEEK	DECIMAL TIME	OA TEMP (F)	HW TEMP (F)	BLDG 1 DEMAND (KW)	BLDG 2 DEMAND (KW)	DECIMAL TIME	TOTAL DEMAND (KW)	JANUARY DEMAND (KW)	JULY DEMAND (KW)
SUNDAY	1.0	46.0	139.4	522.0	882.0	1.0	1404.0	2,981	3,748
	2.0	45.4	139.2	522.0	873.0	2.0	1395.0	2,916	3,672
	3.0	45.5	139.0	486.0	828.0	3.0	1314.0	2,884	3,580
	4.0	43.0	138.1	517.5	882.0	4.0	1399.5	2,894	3,607
	5.0	41.1	138.0	522.0	868.5	5.0	1390.5	2,938	4,045
	6.0	39.1	137.6	486.0	810.0	6.0	1296.0	3,445	4,045
	7.0	37.1	138.1	495.0	828.0	7.0	1323.0	3,364	4,093
	8.0	35.3	137.3	769.5	940.5	8.0	1710.0	3,424	4,180
	9.0	35.6	138.5	639.0	882.0	9.0	1521.0	3,413	4,271
	10.0	36.8	139.0	531.0	855.0	10.0	1386.0	3,451	4,520
	11.0	39.3	138.9	504.0	805.5	11.0	1309.5	3,510	4,282
	12.0	42.9	138.8	513.0	801.0	12.0	1314.0	3,542	4,282
	13.0	46.0	138.9	526.5	819.0	13.0	1345.5	3,532	4,385
	14.0	48.4	139.2	540.0	823.5	14.0	1363.5	3,569	4,568
	15.0	51.1	139.3	580.5	877.5	15.0	1458.0	3,262	4,590
	16.0	50.9	139.4	522.0	819.0	16.0	1341.0	3,224	4,628
	17.0	51.8	139.9	540.0	859.5	17.0	1399.5	3,116	4,606
	18.0	51.0	140.4	490.5	778.5	18.0	1269.0	3,159	4,520
	19.0	49.2	140.1	526.5	909.0	19.0	1435.5	3,159	4,315
	20.0	48.7	140.1	531.0	882.0	20.0	1413.0	3,240	4,190
	21.0	48.6	139.9	522.0	810.0	21.0	1332.0	3,213	4,196
	22.0	48.2	139.9	522.0	895.5	22.0	1417.5	3,386	4,147
	23.0	47.9	139.7	486.0	814.5	23.0	1300.5	3,202	4,082
	24.0	47.1	139.7	522.0	891.0	24.0	1413.0	3,224	3,796
MONDAY	1.0	46.9	139.6	531.0	846.0	25.0	1377.0	3,089	3,710
	2.0	46.3	139.6	490.5	873.0	26.0	1363.5	3,110	3,775
	3.0	45.6	139.2	417.5	891.0	27.0	1308.5	3,089	3,818
	4.0	44.9	139.1	522.0	895.5	28.0	1417.5	3,143	4,077
	5.0	44.2	138.5	504.0	981.0	29.0	1485.0	3,596	4,633
	6.0	44.1	137.6	751.5	1044.0	30.0	1795.5	4,255	5,081
	7.0	43.8	138.7	810.0	1012.5	31.0	1822.5	4,801	6,097
	8.0	43.6	138.7	1008.0	1201.5	32.0	2209.5	5,476	6,502
	9.0	44.0	125.1	949.5	1116.0	33.0	2065.5	5,665	6,658
	10.0	44.8	124.5	1021.5	1107.0	34.0	2128.5	5,675	6,982
	11.0	46.3	124.0	1003.5	1116.0	35.0	2119.5	5,567	7,112
	12.0	47.4	137.8	1264.5	1102.5	36.0	2367.0	5,432	7,236
	13.0	47.5	140.3	1048.5	1111.5	37.0	2160.0	5,389	7,247
	14.0	47.4	139.6	981.0	1147.5	38.0	2128.5	5,324	7,425
	15.0	47.7	139.8	981.0	1116.0	39.0	2097.0	5,222	7,187
	16.0	47.7	140.0	963.0	1111.5	40.0	2074.5	4,990	6,480
	17.0	47.7	139.9	900.0	1071.0	41.0	1971.0	4,304	6,210
	18.0	47.1	140.0	769.5	972.0	42.0	1741.5	4,001	5,481
	19.0	46.4	139.5	792.0	1003.5	43.0	1795.5	4,001	5,254
	20.0	45.2	139.0	742.5	1039.5	44.0	1782.0	3,688	5,189
	21.0	44.3	139.4	760.5	1003.5	45.0	1764.0	3,580	4,865
	22.0	44.0	138.7	549.0	877.5	46.0	1426.5	3,526	4,671
	23.0	44.1	138.7	540.0	877.5	47.0	1417.5	3,434	4,375
	24.0	44.2	138.7	454.5	774.0	48.0	1228.5	3,283	4,201

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BUILDING-200 EMCS PRINTOUT - JANUARY 1992

UTILITY DATA
FORT McPHERSON

DAY OF WEEK	DECIMAL TIME	OA TEMP (F)	HW TEMP (F)	BLDG 1 DEMAND (KW)	BLDG 2 DEMAND (KW)	DECIMAL TIME	TOTAL DEMAND (KW)	JANUARY DEMAND (KW)	JULY DEMAND (KW)
TUESDAY	1.0	44.0	138.5	481.5	841.5	49.0	1323.0	3,218	4,158
	2.0	43.8	138.6	522.0	891.0	50.0	1413.0	3,181	4,077
	3.0	43.9	137.9	531.0	904.5	51.0	1435.5	3,089	4,158
	4.0	43.8	138.5	535.5	877.5	52.0	1413.0	3,121	4,563
	5.0	43.6	138.3	522.0	967.5	53.0	1489.5	3,596	5,060
	6.0	43.6	138.0	783.0	999.0	54.0	1782.0	4,142	5,454
	7.0	43.4	138.5	891.0	1026.0	55.0	1917.0	4,628	6,529
	8.0	43.6	127.8	625.5	967.5	56.0	1593.0	5,427	6,901
	9.0	43.9	111.7	994.5	1143.0	57.0	2137.5	5,492	7,182
	10.0	44.6	103.5	882.0	1143.0	58.0	2025.0	5,405	7,398
	11.0	45.2	113.0	1026.0	1228.5	59.0	2254.5	5,335	7,484
	12.0	46.0	138.8	697.5	1143.0	60.0	1840.5	5,341	7,528
	13.0	47.1	139.1	747.0	1237.5	61.0	1984.5	5,303	7,733
	14.0	48.0	139.0	1102.5	1206.0	62.0	2308.5	5,319	7,798
	15.0	48.2	140.5	1048.5	1201.5	63.0	2250.0	5,249	7,614
	16.0	48.4	140.9	1003.5	1156.5	64.0	2160.0	4,973	6,853
	17.0	48.5	140.1	823.5	972.0	65.0	1795.5	4,342	6,496
	18.0	48.5	140.2	850.5	1048.5	66.0	1899.0	4,039	5,746
	19.0	48.2	140.4	819.0	1035.0	67.0	1854.0	4,034	5,497
	20.0	48.2	140.2	679.5	972.0	68.0	1651.5	3,672	5,405
	21.0	48.3	140.7	729.0	994.5	69.0	1723.5	3,607	5,076
	22.0	48.2	138.7	576.0	868.5	70.0	1444.5	3,407	4,860
	23.0	48.1	139.2	540.0	895.5	71.0	1435.5	3,170	4,649
	24.0	48.1	138.8	544.5	931.5	72.0	1476.0	2,997	4,417
WEDNESDAY	1.0	47.9	138.9	504.0	828.0	73.0	1332.0	2,975	4,282
	2.0	48.1	138.9	490.5	828.0	74.0	1318.5	2,965	4,315
	3.0	48.0	139.5	571.5	913.5	75.0	1485.0	2,911	4,406
	4.0	48.1	139.4	571.5	895.5	76.0	1467.0	2,938	4,801
	5.0	48.0	139.2	625.5	1098.0	77.0	1723.5	3,159	5,346
	6.0	47.9	139.4	819.0	1008.0	78.0	1827.0	3,699	5,773
	7.0	48.1	139.6	936.0	1044.0	79.0	1980.0	4,244	6,637
	8.0	48.1	139.6	1044.0	1242.0	80.0	2286.0	5,114	6,944
	9.0	48.5	140.1	1003.5	1237.5	81.0	2241.0	5,265	7,160
	10.0	49.9	140.5	1012.5	1143.0	82.0	2155.5	5,281	7,393
	11.0	51.4	140.7	1008.0	1116.0	83.0	2124.0	5,330	7,555
	12.0	53.1	140.7	1003.5	1125.0	84.0	2128.5	5,400	7,668
	13.0	54.4	140.7	999.0	1129.5	85.0	2128.5	5,346	7,744
	14.0	55.5	140.9	1084.5	1107.0	86.0	2191.5	5,341	7,792
	15.0	56.4	141.2	1003.5	1102.5	87.0	2106.0	5,297	7,717
	16.0	56.3	141.1	1017.0	1161.0	88.0	2178.0	5,060	6,847
	17.0	56.2	141.0	877.5	1008.0	89.0	1885.5	4,396	5,935
	18.0	55.7	140.7	796.5	967.5	90.0	1764.0	4,201	5,422
	19.0	55.5	140.7	720.0	972.0	91.0	1692.0	4,169	5,092
	20.0	54.4	140.7	711.0	963.0	92.0	1674.0	3,672	4,957
	21.0	54.0	140.7	756.0	999.0	93.0	1755.0	3,456	4,622
	22.0	54.1	140.4	733.5	949.0	94.0	1682.5	3,213	4,374
	23.0	53.5	140.6	526.5	846.0	95.0	1372.5	3,127	4,185
	24.0	44.2	138.7	454.5	774.0	96.0	1228.5	3,040	4,061

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UTILITY DATA
FORT McPHERSON

DAY OF WEEK	DECIMAL TIME	OA TEMP (F)	HW TEMP (F)	BLDG 1 DEMAND (KW)	BLDG 2 DEMAND (KW)	DECIMAL TIME	TOTAL DEMAND (KW)	JANUARY DEMAND (KW)	JULY DEMAND (KW)
THURSDAY	1.0	44.0	138.5	481.5	841.5	97.0	1323.0	3,029	4,039
	2.0	43.8	138.6	522.0	891.0	98.0	1413.0	3,019	4,072
	3.0	43.9	137.9	531.0	904.5	99.0	1435.5	2,975	4,185
	4.0	43.8	138.5	535.5	877.5	100.0	1413.0	2,981	4,374
	5.0	43.6	138.3	522.0	967.5	101.0	1489.5	3,316	5,022
	6.0	43.6	138.0	783.0	999.0	102.0	1782.0	3,872	5,265
	7.0	43.4	138.5	891.0	1026.0	103.0	1917.0	4,390	6,426
	8.0	43.6	127.8	625.5	967.5	104.0	1593.0	5,108	6,788
	9.0	43.9	111.7	994.5	1143.0	105.0	2137.5	5,308	7,063
	10.0	44.6	103.5	882.0	1143.0	106.0	2025.0	5,378	7,349
	11.0	45.2	113.0	1026.0	1228.5	107.0	2254.5	5,378	7,511
	12.0	46.0	138.8	697.5	1143.0	108.0	1840.5	5,368	7,641
	13.0	47.1	139.1	747.0	1237.5	109.0	1984.5	5,351	7,830
	14.0	48.0	139.0	1102.5	1206.0	110.0	2308.5	5,357	7,862
	15.0	48.2	140.5	1048.5	1201.5	111.0	2250.0	5,308	7,722
	16.0	48.4	140.9	1003.5	1156.5	112.0	2160.0	5,076	6,475
	17.0	48.5	140.1	823.5	972.0	113.0	1795.5	4,439	6,399
	18.0	48.5	140.2	850.5	1048.5	114.0	1899.0	4,250	5,702
	19.0	48.2	140.4	819.0	1035.0	115.0	1854.0	4,217	5,357
	20.0	48.2	140.2	679.5	972.0	116.0	1651.5	3,866	5,276
	21.0	48.3	140.7	729.0	994.5	117.0	1723.5	3,737	5,168
	22.0	48.2	138.7	576.0	868.5	118.0	1444.5	3,607	4,946
	23.0	48.1	139.2	540.0	895.5	119.0	1435.5	3,418	4,482
	24.0	41.3	138.7	490.5	810.0	120.0	1300.5	3,272	4,374
FRIDAY	1.0	40.5	138.7	531.0	877.5	121.0	1408.5	3,289	4,244
	2.0	39.7	138.5	522.0	873.0	122.0	1395.0	3,305	4,309
	3.0	39.2	138.6	490.5	868.5	123.0	1359.0	3,299	4,396
	4.0	38.9	138.7	535.5	882.0	124.0	1417.5	3,321	4,655
	5.0	38.1	138.7	513.0	990.0	125.0	1503.0	3,888	5,297
	6.0	37.2	139.0	841.5	1021.5	126.0	1863.0	4,282	5,702
	7.0	36.1	139.0	873.0	1098.0	127.0	1971.0	4,887	6,707
	8.0	35.1	139.4	945.0	1116.0	128.0	2061.0	5,659	7,079
	9.0	35.5	139.2	967.5	1111.5	129.0	2079.0	5,913	7,301
	10.0	37.0	138.9	985.5	1120.5	130.0	2106.0	5,864	7,376
	11.0	37.2	139.4	1071.0	1219.5	131.0	2290.5	5,805	7,452
	12.0	38.2	139.1	985.5	1107.0	132.0	2092.5	5,702	7,544
	13.0	39.4	139.2	1053.0	1165.5	133.0	2218.5	5,578	7,587
	14.0	40.7	139.0	1062.0	1111.5	134.0	2173.5	5,465	7,598
	15.0	41.4	139.2	1053.0	1179.0	135.0	2232.0	5,351	7,355
	16.0	41.9	139.6	931.5	1057.5	136.0	1989.0	5,011	6,707
	17.0	41.7	139.6	828.0	1030.5	137.0	1858.5	4,352	6,356
	18.0	40.7	138.9	828.0	1012.5	138.0	1840.5	4,115	5,616
	19.0	39.1	138.5	724.5	958.5	139.0	1683.0	4,190	5,373
	20.0	37.6	138.0	661.5	949.5	140.0	1611.0	3,899	5,152
	21.0	36.4	138.1	625.5	909.0	141.0	1534.5	3,904	5,184
	22.0	35.3	138.5	522.0	891.0	142.0	1413.0	3,607	4,817
	23.0	34.5	138.3	499.5	828.0	143.0	1327.5	3,391	4,547
	24.0	34.0	138.0	463.5	774.0	144.0	1237.5	3,402	4,390

APPENDIX C

ENERGY CONSERVATION OPPORTUNITY
BACKUP CALCULATIONS

Section	ECO Description
C-1.1	WALL INSULATION
C-1.2	ROOF INSULATION
C-1.3	PIPE AND DUCT INSULATION
C-2	INSULATED GLASS
C-3	WEATHERSTRIPPING AND CAULKING
C-4	MEASURE HOT WATER TEMPERATURES
C-5	ELECTRIC MOTORS
C-6	ADD ECONOMIZERS
C-7	CONTROL HOT WATER CIRCULATION PUMPS
C-8	INSTALL LOW-FLOW SHOWER AND FAUCET FIXTURES
C-9	HEAT RECLAIM FOR HOT REFRIGERANT GAS
C-10	PREVENT AIR STRATIFICATION
C-11	REPLACE STREET LIGHTS
C-12	REVISE OR REPAIR HVAC CONTROLS
C-13	THERMAL STORAGE
C-14.1	LOADING DOCK SEALS
C-14.2	RADIANT HEATERS
C-15.1	BUILDING 200 LIGHTING CONTROLS
C-15.2	SEPARATE SWITCHES TO CONTROL LIGHTING
C-16	INVESTIGATE POST DEMAND USAGE
C-17	EVALUATE BOILER OPERATION
C-18	EXIT SIGN RETROFIT
C-19	LIGHTING UPGRADES
C-20	COMPUTER SIMULATION SUMMARIES

APPENDIX C-1.1

WALL INSULATION

WALL INSULATION SAMPLE CALCULATION, ECO #1
BUILDING 111

Given:

Gross Wall Area	= 2,550 ft^2	- from bldg plans
Window Area	= 380 ft^2	- from bldg plans / survey notes
Existing Wall U-value	= 0.303 Btuh / hr °F ft^2	- from survey notes
Improved Wall U-value	= 0.075 Btuh / hr °F ft^2	- from survey notes
Gas Savings Factor	= 0.020 MBtu / UA	- from Bldg 100 simulation
Electric Savings Factor	= 2.8 kWh / UA	- from Bldg 100 simulation
Demand Savings Factor	= 0.0 kW	- from Bldg 100 simulation
Gas Cost	= $4.67 / MBtu	- from utility rate analysis
Electric Cost	= $0.0255 / kWh	- from utility rate analysis
Demand Cost	= $8.85 / kW	- from utility rate analysis

Net Wall Area:

2,550 ft^2 - 380 ft^2 = 2170 ft^2

Existing Wall UA:

(2,170 ft^2)*(0.303 Btuh / hr °F ft^2) = 657.6 Btuh / hr °F

Improved Wall UA:

(2,170 ft^2)*(0.075 Btuh / hr °F ft^2) = 162.8 Btuh / hr °F

Delta UA:

657.6 - 162.8 = 494.8 Btuh / hr °F

Peak Demand Savings:

(494.8 UA)*(0.0 kW / UA) = 0.0 kW

Annual Energy Savings:

- Gas:	(494.8 UA)*(0.020 MBtu / UA)	= 9.9 MBtu
- Electric:	(494.8 UA)*(2.8 kWh / UA)	= 1,385 kWh

Annual Cost Savings:

(9.9 MBtu)*($4.67 / MBtu) + (1,385 kWh)*($0.0255 / kWh) + (0.0 kW)*($8.85 / kW)*(4 + .95 * 8) = $82 / yr

Estimated Construction Cost:

$4.04 / ft² of wall - from engineer's cost estimate

($4.04 / ft²)*(2,170 ft²) = $8,767

$8,767 + ($8,767 * .O55 SIOH) + ($8,767 * .06 DESIGN) = $9,775

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 1 – Wall Insulation

CLIENT CONTRACT NO: DACA21–91–C–0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 23 APRIL 1992
FILE: ECO–1W.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	23.77 UPWG
Electric Savings	$0.0255 / kWh	15.61 UPWE
Demand Savings	$8.85 / kW	14.53 UPW

Economic Life: 25 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON–ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
181	3	5,392	108	126	$642	$308	$0	$950	$59,393	0.3	63
111	0	1,385	10	15	$82	$0	$0	$82	$9,776	0.2	120
112	0	1,385	10	15	$82	$0	$0	$82	$9,776	0.2	120
114	0	1,385	10	15	$82	$0	$0	$82	$9,776	0.2	120
116	0	1,385	10	15	$82	$0	$0	$82	$9,776	0.2	120
117	0	1,385	10	15	$82	$0	$0	$82	$9,776	0.2	120
118	0	1,385	10	15	$82	$0	$0	$82	$9,776	0.2	120
120	0	1,385	10	15	$82	$0	$0	$82	$9,776	0.2	120
121	0	1,385	10	15	$82	$0	$0	$82	$9,776	0.2	120
122	0	1,385	10	15	$82	$0	$0	$82	$9,776	0.2	120
126	0	1,385	10	15	$82	$0	$0	$82	$9,776	0.2	120
041	0	2,651	19	28	$156	$0	$0	$156	$18,858	0.2	121

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 1 – Wall Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 23 APRIL 1992
FILE: ECO-1W.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG #	WIN AREA (ft^2)	GROSS WALL AREA (ft^2)	NET WALL AREA (ft^2)	EXIST WALL U-VALUE	EXIST WALL UA	IMPRVD WALL U-VALUE	IMPRVD WALL UA	DELTA UA	DEMAND SAVINGS (kW/UA)	ELECTRIC SAVINGS (kWh/UA)	GAS SAVINGS (MBtu/UA)	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	UNIT CONST COST ($/$ft^2$)	CONST COST ($)
041	774	5,705	4,931	0.271	1336.3	0.079	389.5	946.8	0.0	2.8	0.020	0.0	2,651	18.9	$3.43	$16,913
111	380	2,550	2,170	0.303	657.6	0.075	162.8	494.8	0.0	2.8	0.020	0.0	1,385	9.9	$4.04	$8,767
112	380	2,550	2,170	0.303	657.6	0.075	162.8	494.8	0.0	2.8	0.020	0.0	1,385	9.9	$4.04	$8,767
114	380	2,550	2,170	0.303	657.6	0.075	162.8	494.8	0.0	2.8	0.020	0.0	1,385	9.9	$4.04	$8,767
116	380	2,550	2,170	0.303	657.6	0.075	162.8	494.8	0.0	2.8	0.020	0.0	1,385	9.9	$4.04	$8,767
117	380	2,550	2,170	0.303	657.6	0.075	162.8	494.8	0.0	2.8	0.020	0.0	1,385	9.9	$4.04	$8,767
118	380	2,550	2,170	0.303	657.6	0.075	162.8	494.8	0.0	2.8	0.020	0.0	1,385	9.9	$4.04	$8,767
120	380	2,550	2,170	0.303	657.6	0.075	162.8	494.8	0.0	2.8	0.020	0.0	1,385	9.9	$4.04	$8,767
121	380	2,550	2,170	0.303	657.6	0.075	162.8	494.8	0.0	2.8	0.020	0.0	1,385	9.9	$4.04	$8,767
122	380	2,550	2,170	0.303	657.6	0.075	162.8	494.8	0.0	2.8	0.020	0.0	1,385	9.9	$4.04	$8,767
126	380	2,550	2,170	0.303	657.6	0.075	162.8	494.8	0.0	2.8	0.020	0.0	1,385	9.9	$4.04	$8,767
181			13,185	0.169	2228.3	0.063	830.7	1,397.6	0.0021	3.9	0.077	3.0	5,392	108	$4.04	$53,267

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study
LOCATION Ft. McPherson & Ft Gillem

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097
X CODE A ☐ CODE B ☐ CODE C ☐ OTHER ____

EFFECTIVE PRICING DATE APR 92
DRAWING NO.
ESTIMATOR RMG

DATE PREPARED 15-Apr-92
SHT OF
CHECKED BY

ECO 1 – Interior Wall Insulation	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
ISOCYANURATE, FOIL FACED, 1"	1	SF	0.012	0.012	$18.53	$0.22			$0.60	$0.60	$0.82		
Z STUD, GALV, 1-1/2" WIDE	1	SF	0.018	0.018	$18.53	$0.33			$0.14	$0.14	$0.47		
DRYWALL, 5/8", TAPED & FINISHED	1	SF	0.020	0.020	$18.53	$0.37			$0.31	$0.31	$0.68		
WALL SWITCH, LIGHTS	0.01	CSF	0.240	0.002	$21.17	$0.05			$4.08	$0.04	$0.09		
RECEPTACLE, DUPLEX, 120 VOLT	0.01	CSF	0.240	0.002	$21.17	$0.05			$2.10	$0.02	$0.07		
PAINT, 2 COATS, SPRAY	1	SF	0.006	0.006	$17.27	$0.10			$0.14	$0.14	$0.25		
SUBTOTAL											$2.39		
OVERHEAD, BOND	15%										$0.36		
PROFIT	10%										$0.24		
COST SUB-TOTAL											$2.98		
CONTINGENCY	15%										$0.45		
SUBTOTAL											$3.43		
S&A													
TOTAL											$3.43		

DA FORM 5416-R, APR 85

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

X CODE A ☐ CODE B ☐ CODE C ☐ OTHER

EFFECTIVE PRICING DATE APR 92

DATE PREPARED 15-Apr-92

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

DRAWING NO.

SHT OF

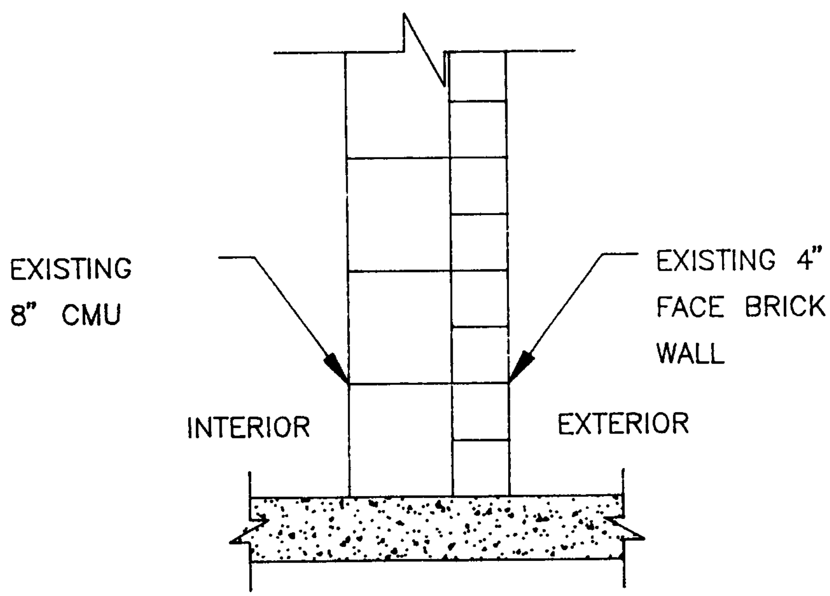
ESTIMATOR RMG

CHECKED BY

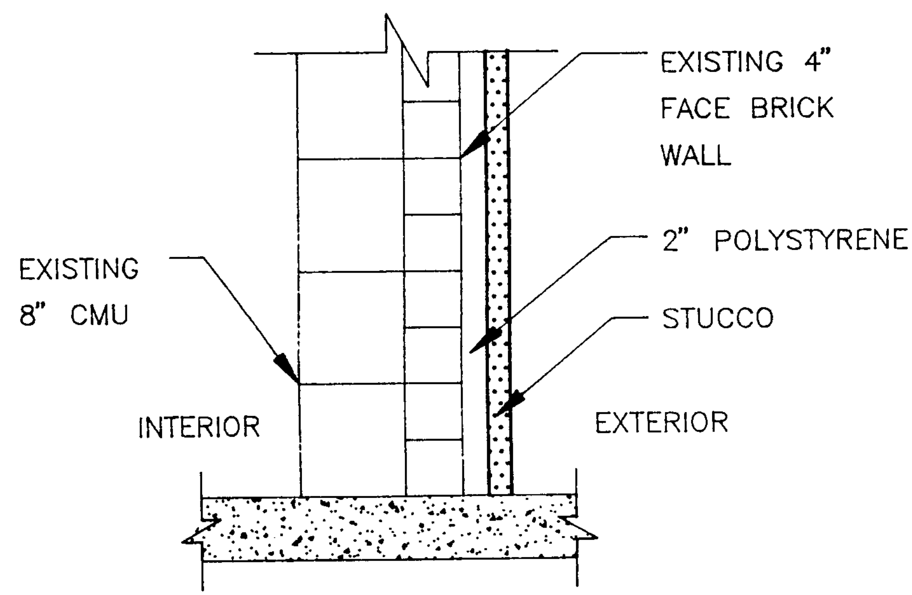
ECO 1 – Wall Insulation, exterior	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
POLYSTYRENE, EXTRUDED, 2"	1	SF	0.011	0.011	$18.53	$0.20			$0.88	$0.88	$1.08		
STUCCO, 3 COATS, 1" THICK, MESH	1	SF	0.081	0.081	$18.53	$1.50			$0.23	$0.23	$1.72		
SUBTOTAL											$2.81		
OVERHEAD, BOND	15%										$0.42		
PROFIT	10%										$0.28		
COST SUB-TOTAL											$3.51		
CONTINGENCY	15%										$0.53		
SUBTOTAL											$4.04		
S&A													
TOTAL											$4.04		

DA FORM 5418-R, APR 85

ADD 2" POLYSTYRENE AND STUCCO

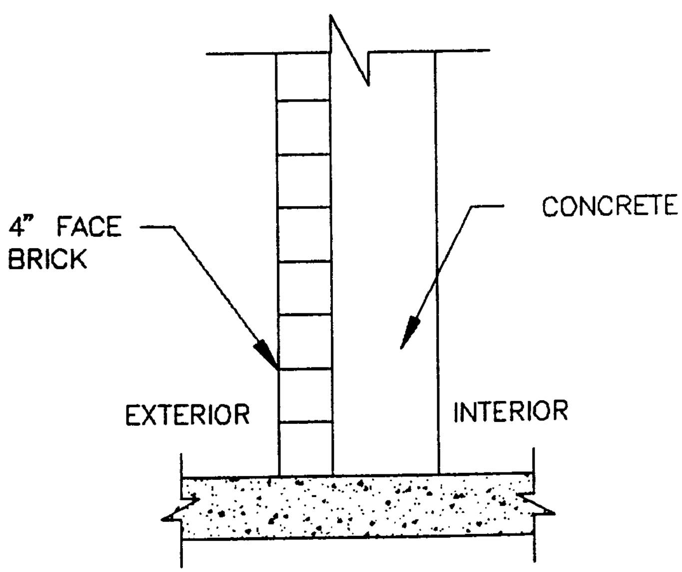


NO INSULATION

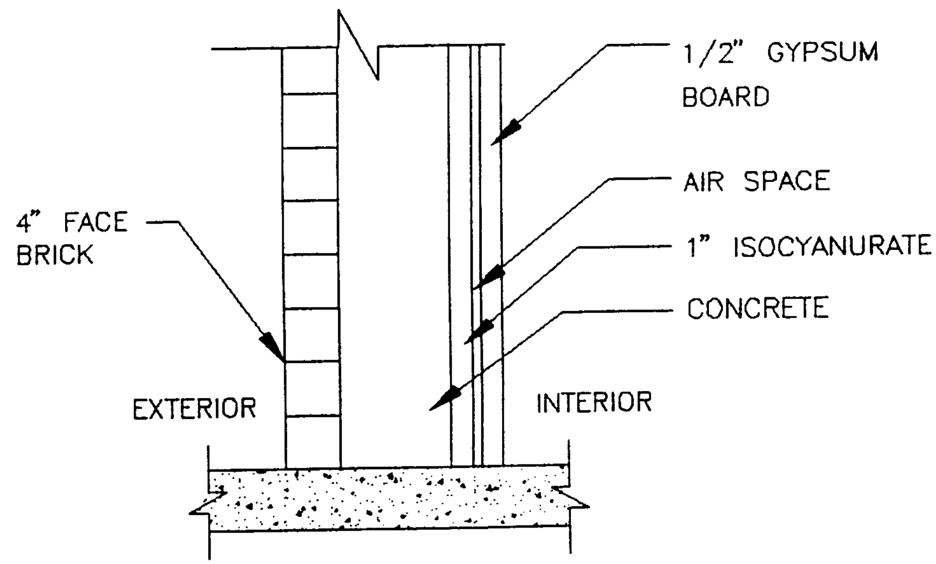


INSULATION

ADD 1" ISOCYANURATE AND GYPSUM BOARD



NO INSULATION



INSULATION

APPENDIX C-1.2

ROOF INSULATION

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: MECO1
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-1 ROOF INSULATION
ANALYSIS DATE: 07-09-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	3400.
B. SIOH	$	187.
C. DESIGN COST	$	204.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	3791.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	11.	$ 81.	15.61	1260.
B. DIST	$ .00	0.	$ 0.	21.66	0.
C. RESID	$ .00	0.	$ 0.	26.51	0.
D. NAT G	$ 4.67	51.	$ 238.	23.77	5661.
E. COAL	$ .00	0.	$ 0.	16.06	0.
F. TOTAL		62.	$ 319.		$ 6921.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 406.
(1) DISCOUNT FACTOR (TABLE A) 14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 5899.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 5899.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 2284.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) 2.43
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 725.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 12820.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 3.38
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 5.23

ROOF INSULATION SAMPLE CALCULATION, ECO #1
BUILDING 111

Given:

Roof Area	= 2,150 ft^2	- from bldg plans
Existing Roof U-value	= 0.202 Btuh / hr °F ft^2	- from survey notes
Improved Roof U-value	= 0.042 Btuh / hr °F ft^2	- from survey notes
Gas Savings Factor	= 0.0083 MBtu / UA	- from Bldg 100 simulation
Electric Savings Factor	= 1.8 kWh / UA	- from Bldg 100 simulation
Demand Savings Factor	= 0.0 kW	- from Bldg 100 simulation
Gas Cost	= $4.67 / MBtu	- from utility rate analysis
Electric Cost	= $0.0255 / kWh	- from utility rate analysis
Demand Cost	= $8.85 / kW	- from utility rate analysis

Existing Roof UA:

(2,150 ft^2)*(0.202 Btuh / hr °F ft^2) = 434.3 Btuh / hr °F

Improved Roof UA:

(2,150 ft^2)*(0.042 Btuh / hr °F ft^2) = 90.3 Btuh / hr °F

Delta UA:

434.3 - 90.3 = 344.0 Btuh / hr °F

Peak Demand Savings:

(344.0 UA)*(0.0 kW / UA) = 0.0 kW

Annual Energy Savings:

- Gas:	(344.0 UA)*(0.0083 MBtu / UA)	= 2.9 MBtu
- Electric:	(344.0 UA)*(1.8 kWh / UA)	= 619 kWh

Annual Cost Savings:

(2.9 MBtu)*($4.67 / MBtu) + (619 kWh)*($0.0255 / kWh) + (0.0 kW)*($8.85 / kW)*(4 + .95 * 8) = $29 / yr

Estimated Construction Cost:

$0.68 / ft^2 of wall - from engineer's cost estimate

($0.68 / ft^2)*(2,150 ft^2) = $1,462

$1,462 + ($1,462 * .055 SIOH) + ($1,462 * .06 DESIGN) = $1,630

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 1 – Roof Insulation

CLIENT CONTRACT NO: DACA21–91–C–0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 16–Jul–92
FILE: ECO–1R.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	23.77 UPWG
Electric Savings	$0.0255 / kWh	15.61 UPWE
Demand Savings	$8.85 / kW	14.53 UPW

Economic Life: 25 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON–ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
168	4	3,164	51	62	$318	$406	$0	$724	$3,791	3.4	5.2
TOTAL	4	3,164	51	62	$318	$406	$0	$724	$3,791	3.4	5.2
111	0	619	3	5	$29	$0	$0	$29	$1,630	0.3	56.0
112	0	619	3	5	$29	$0	$0	$29	$1,630	0.3	56.0
114	0	619	3	5	$29	$0	$0	$29	$1,630	0.3	56.0
116	0	619	3	5	$29	$0	$0	$29	$1,630	0.3	56.0
117	0	619	3	5	$29	$0	$0	$29	$1,630	0.3	56.0
118	0	619	3	5	$29	$0	$0	$29	$1,630	0.3	56.0
120	0	619	3	5	$29	$0	$0	$29	$1,630	0.3	56.0
121	0	619	3	5	$29	$0	$0	$29	$1,630	0.3	56.0
122	0	619	3	5	$29	$0	$0	$29	$1,630	0.3	56.0
126	0	619	3	5	$29	$0	$0	$29	$1,630	0.3	56.0

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 1 – Roof Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-APR-92
FILE: ECO-1R.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG #	ROOF AREA (ft^2)	EXIST ROOF U-VALUE	EXIST ROOF UA	IMPRVD ROOF U-VALUE	IMPRVD ROOF UA	DELTA UA	DEMAND SAVINGS (kW/UA)	ELECTRIC SAVINGS (kWh/UA)	GAS SAVINGS (MBtu/UA)	PEAK DEMAND SAVINGS (kW/yr)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	UNIT CONST COST ($/ft²)	CONST COST ($)
111	2150	0.202	434.3	0.042	90.3	344.0	0	1.8	0.0083	0	619	2.9	$0.68	$1,462
112	2150	0.202	434.3	0.042	90.3	344.0	0	1.8	0.0083	0	619	2.9	$0.68	$1,462
114	2150	0.202	434.3	0.042	90.3	344.0	0	1.8	0.0083	0	619	2.9	$0.68	$1,462
116	2150	0.202	434.3	0.042	90.3	344.0	0	1.8	0.0083	0	619	2.9	$0.68	$1,462
117	2150	0.202	434.3	0.042	90.3	344.0	0	1.8	0.0083	0	619	2.9	$0.68	$1,462
118	2150	0.202	434.3	0.042	90.3	344.0	0	1.8	0.0083	0	619	2.9	$0.68	$1,462
120	2150	0.202	434.3	0.042	90.3	344.0	0	1.8	0.0083	0	619	2.9	$0.68	$1,462
121	2150	0.202	434.3	0.042	90.3	344.0	0	1.8	0.0083	0	619	2.9	$0.68	$1,462
122	2150	0.202	434.3	0.042	90.3	344.0	0	1.8	0.0083	0	619	2.9	$0.68	$1,462
126	2150	0.202	434.3	0.042	90.3	344.0	0	1.8	0.0083	0	619	2.9	$0.68	$1,462
168	5000	0.270	1350.0	0.044	220.0	1130.0	0.0035	2.8	0.045	4.0	3,164	50.9	$0.68	$3,400

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

X CODE A   CODE B   CODE C   OTHER ______

EFFECTIVE PRICING DATE APR 92

DATE PREPARED 15-Apr-92

DRAWING NO.

SHT OF

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

ESTIMATOR RMG

CHECKED BY

ECO 1 – Roof	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
FIBERGLASS BATTS, R-19	1	SF	0.005	0.005	$18.53	$0.09			$0.38	$0.38	$0.47		
SUBTOTAL											$0.47		
OVERHEAD, BOND	15%										$0.07		
PROFIT	10%										$0.05		
COST SUB-TOTAL											$0.59		
CONTINGENCY	15%										$0.09		
SUBTOTAL											$0.68		
S&A													
TOTAL											$0.68		

DA FORM 5416-R, APR 85

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study
LOCATION Ft. McPherson & Ft Gillem

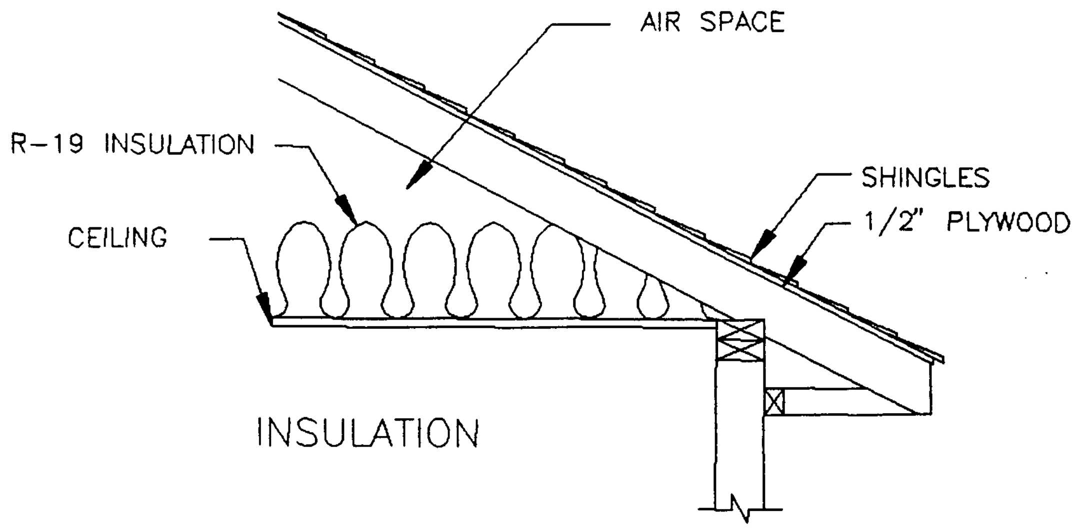
INVITATION NO./CONTRACT NO. DACA 21-91-C-0097
[X] CODE A [ ] CODE B [ ] CODE C
[ ] OTHER ______

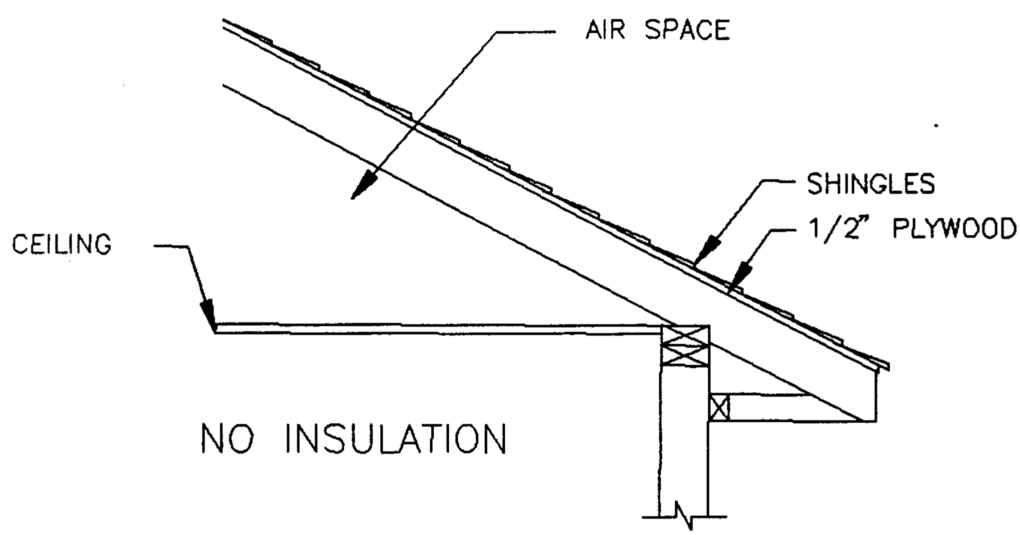
EFFECTIVE PRICING DATE APR 92
DRAWING NO.
ESTIMATOR RMG

DATE PREPARED 16-Apr-92
SHT OF
CHECKED BY

ECO 1 – Roof, Warehouse	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
ISOCYANURATE, FOIL FACED, 3" THICK	1	SF	0.011	0.011	$18.53	$0.20			$1.49	$1.49	$1.69		
AERIAL LIFT, TELESCOPING BOOM	0.011	HR					$5.60	$0.06			$0.06		
SUBTOTAL											$1.76		
OVERHEAD, BOND	15%										$0.26		
PROFIT	10%										$0.18		
COST SUB-TOTAL											$2.19		
CONTINGENCY	15%										$0.33		
SUBTOTAL											$2.52		
S&A													
TOTAL											$2.52		

DA FORM 5418-R, APR 85


AIR SPACE
R-19 INSULATION
SHINGLES
1/2" PLYWOOD
CEILING
INSULATION


AIR SPACE
SHINGLES
1/2" PLYWOOD
CEILING
NO INSULATION

APPENDIX C-1.3

PIPE AND DUCT INSULATION

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

STUDY: MECO1
LCCID 1.062

INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-1 DUCT INSULATION
ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	8632.
B. SIOH	$	475.
C. DESIGN COST	$	518.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	9625.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	102.	$ 762.	15.61	11896.
B. DIST	$ .00	0.	$ 0.	21.66	0.
C. RESID	$ .00	0.	$ 0.	26.51	0.
D. NAT G	$ 4.67	243.	$ 1135.	23.77	26974.
E. COAL	$ .00	0.	$ 0.	16.06	0.
F. TOTAL		345.	$ 1897.		$ 38871.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 12827.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 1897.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 38871.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 4.04
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 5.07

DUCT INSULATION SAMPLE CALCULATION, ECO #1
BUILDING G101

Given:

Duct Perimeter	= 80 in	- from bldg plans / survey notes
Duct Length	= 45 ft	- from bldg plans / survey notes
Existing Ins. Thickness	= 0.5 in	- from survey notes
Improved Ins. Thickness	= 2.0 in	- assumed
Ins. Thermal Cond.	= 0.26 Btuh in / ft² °F	- from ASHRAE
Inner Film R-Value	= 0.22 ft² °F / Btuh	- from ASHRAE
Outer Film R-Value	= 0.65 ft² °F / Btuh	- from ASHRAE
Duct Temp. -Heating	= 90 °F	- assumed
Duct Temp. -Cooling	= 55 °F	- assumed
Amb. Temp. Winter	= 75 °F	- assumed
Amb. Temp. Summer	= 90 °F	- assumed
Delta Enthalpy - Summer	= 15.6 Btu / lbm	- assumed
Leakage Class w/o insul.	= 48 cfm / 100ft²	- SMACNA *
Leakage Class w/ added insul	= 24 cfm / 100 ft²	- SMACNA *
Static Pressure	= 0.5 in. w.g.	- assumed
Gas Heater Efficiency	= 75%	- assumed
Gas Cost	= $4.67 / MBtu	- from utility rate analysis
Electric Cost	= $0.0255 / kWh	- from utility rate analysis
Demand Cost	= $8.85 / kW	- from utility rate analysis

* Per SMACNA "HVAC Systems Duct Design," 1990-Third Edition

Duct Surface Area:

$(80 \text{ in} / 12 \text{ in} / \text{ft})*(45 \text{ ft}) = 300 \text{ ft}^2$

Existing Insulation R-Value:

$1 / ((0.26 \text{ Btuh in} / \text{ft}^2 \text{ °F}) / (0.5 \text{ in})) = 1.92 \text{ ft}^2 \text{ °F} / \text{Btuh}$

Existing U-Value:

$1 / (0.22 + 1.92 + 0.65 \text{ ft}^2 \text{ °F} / \text{Btuh}) = 0.36 \text{ Btuh} / \text{ft}^2 \text{ °F}$

Improved Insulation R-Value:

$1 / ((0.26 \text{ Btuh in} / \text{ft}^2 \text{ °F}) / (2.0 \text{ in})) = 7.69 \text{ ft}^2 \text{ °F} / \text{Btuh}$

Improved U-Value:

$1 / (0.22 + 7.69 + 0.65 \text{ ft}^2 \text{ °F} / \text{Btuh}) = 0.12 \text{ Btuh} / \text{ft}^2 \text{ °F}$

Existing Leakage Rate:

$(48 \text{ cfm} / 100 \text{ ft}^2)*(0.5)^{0.65} = 30.6 \text{ cfm} / 100 \text{ ft}^2$

Total Leakage

$$(30.6 \text{ cfm} / 100 \text{ ft}^2) * (300 \text{ ft}^2) = 91.8 \text{ cfm}$$

Improved Leakage Rate

$$(24 \text{ cfm} / 100 \text{ ft}^2) * (0.5)^{0.65} = 15.3 \text{ cfm} / 100 \text{ ft}^2$$

Total Leakage

$$(15.3 \text{ cfm} / 100 \text{ ft}^2) * (300 \text{ ft}^2) = 45.9 \text{ cfm}$$

Existing Energy Usage:

Winter (gas):

Insulation

$$(0.36 \text{ Btuh} / \text{ft}^2 \text{ °F})*(300 \text{ ft}^2)*(90 - 75 \text{ °F}) / 0.75 = 2{,}160 \text{ Btuh}$$

Leakage

$$\frac{(1.1 \text{ Btuh} / \text{cfm °F}) * (91.8 \text{ cfm})(90 - 75 \text{ °F})}{0.75} = 2020 \text{ Btuh}$$

Total

$$(2020 + 2160) = 4180 \text{ Btuh}$$
$$(4180 \text{ Btuh}) * (4380 \text{ hrs}) = 18.3 \text{ MBtu}$$

Summer (electric):

Insulation

$$(0.36 \text{ Btuh} / \text{ft}^2 \text{ °F})*(300 \text{ ft}^2)*(90 - 55 \text{ °F})*(5.83\text{E-}5 \text{ kW} / \text{Btuh})= 0.22 \text{ kW}$$

Leakage

$$(4.5 \text{ lbm} / \text{cfm hr}) + (91.8 \text{ cfm}) * (15.6 \text{ Btu} / \text{lbm}) * (5.83\text{E-}5 \text{ kw} / \text{Btuh}) = 0.38 \text{ kw}$$

Total

$$(0.22 + 0.38) = 0.60 \text{ kw}$$
$$(0.60 \text{ kw}) * (4380 \text{ hrs}) = 2628 \text{ kwh}$$

Improved Energy Usage:

Winter (gas):

Insulation

$$(0.12 \text{ Btuh / ft}^2 \text{ °F})*(300 \text{ ft}^2)*(90 - 75 \text{ °F}) / 0.75 = 701 \text{ Btuh}$$

Leakage

$$\frac{(1.1 \text{ Btuh / cfm °F}) * (45.9 \text{ cfm})(90 - 75 \text{ °F}}{0.75} = 1010 \text{ Btuh}$$

Total

$(7.1 + 1010) = 1711$ Btuh
$(1711$ Btuh$) * (4380$ hrs$) = 7.5$ MBtu

Summer (electric):

Insulation

$$(0.12 \text{ Btuh / ft}^2 \text{ °F})*(300 \text{ ft}^2)*(90 - 55 \text{ °F})*(5.83\text{E-}5 \text{ kW / Btuh})= 0.071 \text{ kW}$$

Leakage

$$(4.5 \text{ lbm / cfm hr}) * (45.9 \text{ cfm}) (15.6 \text{ Btu / lbm}) * (5.83\text{E-}5 \text{ kw / Btuh})= 0.19 \text{ kw}$$

Total

$(0.071 + 0.19) = 0.26$ kw
$(0.26$ kw$) * (4380$ yrs$) = 1134$ kwh

Peak Demand Savings: 0 kW

Annual Energy Savings:

- Electric:	(2628 - 1134 kWh)	= 1494 kW
- Gas:	(18.3 - 7.5 MBtu)	= 10.8 MBtu

Annual Cost Savings:

(10.8 MBtu)*($4.67 / MBtu) + (1494 kWh)*($0.0255 / kWh) + (0 kW)*($8.85 / kW)*(4 + .95 * 8) = $89 / yr

Estimated Construction Cost:

$3.05 / ft² of insulation - from engineer's cost estimate

($3.05 / ft²)*(300 ft²) = $915

$915 + ($915 * .055 SIOH) + ($915 * .06 DESIGN) = $1,020

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 1 – Duct Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 16-Jul-92
FILE: ECO-1DM.WK3
PREPARED BY: CMD
CHECKED BY: CEL

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	23.77 UPWG
Electric Savings	$0.0255 / kWh	15.61 UPWE
Demand Savings	$8.85 / kW	14.53 UPW

Economic Life: 25 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON-ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
105	0	469	4	5	$29	$0	$0	$29	$104	5.7	3.6
116	0	10,385	86	121	$665	$0	$0	$665	$2,701	5.1	4.1
358	0	9,412	77	110	$602	$0	$0	$602	$2,426	5.1	4.0
42	0	7,408	61	87	$475	$0	$0	$475	$1,945	5.0	4.1
118	0	1,982	15	22	$122	$0	$0	$122	$2,449	1.0	20.1
TOTAL	0	29,656	243	345	$1,893	$0	$0	$1,893	$9,625	4.0	5.1
102	0	1,092	8	11	$63	$0	$0	$63	$1,825	0.7	28.9
41	0	619	4	6	$35	$0	$0	$35	$1,088	0.7	30.8
114	0	1,216	7	11	$64	$0	$0	$64	$2,857	0.4	44.8
400	0	1,954	11	18	$102	$0	$0	$102	$4,591	0.4	44.8
22	0	556	3	5	$29	$0	$0	$29	$1,306	0.4	44.8
155	0	884	4	7	$41	$0	$0	$41	$2,721	0.3	66.1

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: MECO1
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-1 PIPE INSULATION
ANALYSIS DATE: 07-17-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	9611.
B. SIOH	$	529.
C. DESIGN COST	$	577.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	10717.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	0.	$ 1.	15.61	10.
B. DIST	$ .00	0.	$ 0.	21.66	0.
C. RESID	$ .00	0.	$ 0.	26.51	0.
D. NAT G	$ 4.67	880.	$ 4110.	23.77	97685.
E. COAL	$ .00	0.	$ 0.	16.06	0.
F. TOTAL		880.	$ 4110.		$ 97695.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 32239.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 4110.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 97695.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 9.12
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 2.61

PIPE INSULATION SAMPLE CALCULATION, ECO #1
BUILDING G101

Given:

Pipe Diameter	= 2.0 in	- from bldg plans / survey notes
Pipe Length	= 100 ft	- from bldg plans / survey notes
Existing Ins. Thickness	= 1.0 in	- from survey notes
Improved Ins. Thickness	= 1.5 in	- assumed
Ins. Thermal Cond.	= 0.26 Btuh in / ft^2 °F	- from ASHRAE
Fluid Temperature	= 140 °F	- assumed
Amb. Temperature	= 50 °F	- assumed
Gas Boiler Efficiency	= 75%	- assumed
Gas Cost	= $4.67 / MBtu	- from utility rate analysis
Electric Cost	= $0.0255 / kWh	- from utility rate analysis
Demand Cost	= $8.85 / kW	- from utility rate analysis

Existing Conductance Coefficient:

ln((2 + 2 * 1.0)/2)/(2 * pi *((0.26 Btuh in / ft^2 °F)/(12 in / ft))
= 5.09 ft °F / Btuh

Existing Pipe Surface Temperature:

assume Rc = 1 ft °F / Btuh

(50 °F) + (140 - 50 °F)*(1 ft °F / Btuh)/(1 + 5.09 ft °F / Btuh)
= 64.8 °F

Existing Convection Coefficient:

hc = 0.18*(64.8 - 40)^0.33 = 0.52 Btuh / ft^2 °F
A = pi * 2 in * (1 ft / 12 in) = 0.52 ft^2 / ft

1 / ((0.52 Btuh / ft^2 °F)*(0.52 ft^2 / ft)) = 3.68 ft °F / Btuh

After 5 iterations:

Ts = 74.1 °F
Rc = 1.86 ft °F / Btuh

Existing Combined Coefficient of Resistance:

5.09 + 1.86 = 6.95 ft °F / Btuh

Existing Annual Energy Loss:

(140 - 50 °F)*(100 ft) /((6.95 ft °F / Btuh)*(0.75)) = 1,727 Btuh

$(1,727 \text{ Btuh})*(4,380 \text{ hrs/yr}) = 7.6 \text{ MBtu/yr}$

Improved Conductance Coefficient:

$\ln((2 + 2 * 1.5)/2)/(2 * \text{pi} *((0.26 \text{ Btuh in} / \text{ft}^2 \text{ °F})/(12 \text{ in} / \text{ft}))$
$= 6.73 \text{ ft °F} / \text{Btuh}$

Improved Pipe Surface Temperature:

assume $Rc = 1 \text{ ft °F} / \text{Btuh}$

$(50 \text{ °F}) + (140 - 50 \text{ °F})*(1 \text{ ft °F} / \text{Btuh})/(1 + 6.73 \text{ ft °F} / \text{Btuh})$
$= 61.6 \text{ °F}$

Improved Convection Coefficient:

$hc = 0.18*(61.6 - 40)\char`^0.33 = 0.50 \text{ Btuh} / \text{ft}^2 \text{ °F}$
$A = \text{pi} * 2 \text{ in} * (1 \text{ ft} / 12 \text{ in}) = 0.52 \text{ ft}^2 / \text{ft}$

$1 / ((0.50 \text{ Btuh} / \text{ft}^2 \text{ °F})*(0.52 \text{ ft}^2 / \text{ft})) = 3.85 \text{ ft °F} / \text{Btuh}$

After 5 iterations:

$Ts = 67.7 \text{ °F}$
$Rc = 1.65 \text{ ft °F} / \text{Btuh}$

Improved Combined Coefficient of Resistance:

$6.73 + 1.65 = 8.38 \text{ ft °F} / \text{Btuh}$

Improved Energy Loss:

$(140 - 50 \text{ °F})*(100 \text{ ft}) / ((8.38 \text{ ft °F} / \text{Btuh})*(0.75)) = 1,431 \text{ Btuh}$
$(1,431 \text{ Btuh})*(4,380 \text{ hrs/yr}) = 6.3 \text{ MBtu/yr}$

Peak Demand Savings: 0 kW

Annual Energy Savings:

- Electric:		= 0 kW
- Gas:	(7.6 - 6.3 MBtu)	= 1.3 MBtu

Annual Cost Savings:

(1.3 MBtu)*($4.67 / MBtu) + (0 kWh)*($0.0255 / kWh) + (0 kW)*($8.85 / kW)*(4 + .95 * 8) = $6 / yr

Estimated Construction Cost:

$4.57 / ft of 1-1/2" insulation on 2" pipe - from engineer's cost estimate

($4.57 / ft)*(100 ft) = $457

1,334 -small construction cost

$457 + $1,334 = $1791

$1791 + ($1791 * .055 SIOH) + ($1791 * .06 DESIGN) = $1,997

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 1 – Pipe Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 16-Jul-92
FILE: ECO-1.WK3
PREPARED BY: CMD
CHECKED BY: CEL

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	23.77 UPWG
Electric Savings	$0.0255 / kWh	15.61 UPWE
Demand Savings	$8.85 / kW	14.53 UPW

Economic Life: 25 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON-ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
155	0	0	653.61	654	$3,052	$0	$0	$3,052	$3,364	21.6	1.1
360	0	0	41.25	41	$193	$0	$0	$193	$303	15.1	1.6
111	0	4	12.37	12	$58	$0	$0	$58	$155	8.8	2.7
61	0	0	105.17	105	$491	$0	$0	$491	$3,564	3.3	7.3
117	0	20	7.95	8	$38	$0	$0	$38	$283	3.1	7.5
112	0	0	59.60	60	$278	$0	$0	$278	$3,047	2.2	10.9
TOTAL	0	24	880	880	$4,110	$0	$0	$4,110	$10,717	9.1	2.6
41	0	0	3.05	3	$14	$0	$0	$14	644	0.5	45.2
109	0	0	0.80	1	$4	$0	$0	$4	328	0.3	87.7
522	0	0	1.47	1	$7	$0	$0	$7	849	0.2	123.6
42	0	0	0.38	0	$2	$0	$0	$2	226	0.2	127.5

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: DUCT AND PIPE INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 17-Apr-92
FILE: MDUCTPIP.WK3
PREPARED BY: CMD
CHECKED BY: CEL

HOT WATER PIPES

BLDG #	PIPE DIA. (IN)	LENGTH (FT)	SURVEY THICKNESS (IN)	SURVEY TYPE	REQUIRED INSULATION (IN)	REMARKS
22	1.5	150	0.5	Rubber	1.5	
27	2	250	1	Fiberglass	1.5	DTW Pipe
	1.25	200	1	Fiberglass	1.5	DTW Pipe
28	2	250	1	Fiberglass	1.5	DTW Pipe
	1.25	200	1	Fiberglass	1.5	DTW Pipe
40	4	50	0.5	Rubber	1.5	
	1.5	200	0.75	Fiberglass	1.5	
41	3	150	0.5	Rubber	1.5	
	2	50	0.5	Rubber	1.5	
42	1.5	40	1	Fiberglass	1.5	DTW Pipe
61	2	100	1	Fiberglass	1.5	
	4	85	2	Foam	1.5	
	3	90	1	Fiberglass	1.5	
100	3.5	200	1	Fiberglass	1.5	
101	4	25	1.5	Fiberglass	1.5	
102	N/A	–	–	–	–	
105	N/A	–	–	–	–	
109	2.5	50	1	Fiberglass	1.5	
111	2	15	0	–	1.5	
112	N/A	–	–	–	–	
114	N/A	–	–	–	–	
116	N/A					
117	2	10	1.25	Rubber	1.5	DTW Pipe
	2	15	0.5	Rubber	1.5	
	2	4	0	–	1.5	
118	N/A	–	–	–	–	
124	N/A	–	–	–	–	
155	N/A	–	–	–	–	
178	N/A	–	–	–	–	
179	3	180	1	Rubber	1.5	DTW Pipe
	2	30	1	Rubber	1.5	DTW Pipe
358	3	40	1.75	Foam	1.5	
	1.5	40	0.75	Rubber	1.5	
	1.5	200	2	Fiberglass	1.5	
	1.5	25	0.75	Rubber	1.5	
	1.25	30	1	Rubber	1.5	
360	2	50	0	–	1.5	
400	N/A	–	–	–	–	
522	1.5	150	1	Fiberglass	1.5	

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: DUCT AND PIPE INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 17-Apr-92
FILE: MDUCTPIP.WK3
PREPARED BY: CAMERAN DIBAI
CHECKED BY: CEL

STEAM PIPES

BLDG #	PIPE DIA. (IN)	LENGTH (FT)	SURVEY		REQUIRED	REMARKS
			THICKNESS (IN)	TYPE	INSULATION (IN)	
22	N/A	–	–	–	–	
27	N/A	–	–	–	–	
28	N/A	–	–	–	–	
40	5	35	2	Fiberglass	3.5	Low Press.
	1	20	1	Fiberglass	1.5	Condensate
41	N/A	–	–	–	–	
42	N/A	–	–	–	–	
61	2	40	1	Fiberglass	1.5	Condensate
	4	50	1.5	Fiberglass	2.5	Low Press.
	3	60	1	Fiberglass	2.5	Low Press.
	2	10	0	–	2.5	
	1	10	0	–	1.5	Condensate
	2	70	1.5	Fiberglass	2.5	
	1.5	40	0	–	1.5	Condensate
	3	40	1	Fiberglass	1.5	Low Press.
100	N/A	–	–	–	–	
101	N/A	–	–	–	–	
102	N/A	–	–	–	–	
105	N/A	–	–	–	–	
109	N/A	–	–	–	–	
111	N/A	–	–	–	–	
112	4	25	0.75	Fiberglass	3	
	3	6	0	–	2.5	Fiberglass
	3.5	38	1	Fiberglass	3	
	2	185	1	Fiberglass	1.5	Condensate
	1.5	185	1	Fiberglass	2.5	
114	N/A	–	–	–	–	
116	N/A					
117	N/A	–	–	–	–	Fiberglass
118	N/A	–	–	–	–	
155	3.5	200	0	–	3	
	1	200	0	–	1.5	Condensate
178	N/A	–	–	–	–	
179	N/A	–	–	–	–	
358	N/A	–	–	–	–	
360	N/A	–	–	–	–	
400	N/A	–	–	–	–	
522	N/A	–	–	–	–	

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: DUCT AND PIPE INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 17-Apr-92
FILE: MDUCTPIPE.WK3
PREPARED BY: CMD
CHECKED BY: CEL

CHILLED WATER PIPES

BLDG #	PIPE DIA. (IN)	LENGTH (FT)	SURVEY		REQUIRED INS. (IN)
			THICKNESS (IN)	TYPE	
22	1.5	150	0.5	Rubber	0.75
27	N/A	–	–	–	–
28	N/A	–	–	–	–
40	4.5	75	0.5	Rubber	1
	3	39	2	Foam	1
41	N/A	–	–	–	–
42	N/A	–	–	–	–
61	N/A	–	–	–	–
100	N/A	–	–	–	–
101	4	80	1.5	Fiberglass	1
102	N/A	–	–	–	–
105	N/A	–	–	–	–
109	2.5	50	1	Fiberglass	1
111	2	15	0.5	Rubber	0.75
112	N/A	–	–	–	–
114	N/A	–	–	–	–
116	N/A	–	–	–	–
117	2	25	0.5	Rubber	0.75
118	N/A	–	–	–	–
155	N/A	–	–	–	–
178	N/A	–	–	–	–
179	N/A	–	–	–	–
358	3	200	2	Fiberglass	1
	3	10	1.5	Fiberglass	1
	1.25	30	1	Rubber	0.75
360	N/A	–	–	–	–
400	N/A	–	–	–	–
522	1	150	1	Fiberglass	0.5
	1.5	150	1	Fiberglass	0.75

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 1 – Duct Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 10-JUL-92
FILE: ECO-1DM.WK3
PREPARED BY: CMD
CHECKED BY: CEL

DUCTS

BLDG #	DUCT SIZE (in)	PERIMITER LENGTH	DUCT LENGTH (ft)	SURVEY		REQUIRED INS. (in)
				THICKNESS (in)	TYPE	
22	24 * 24	96	48	1	Fiberglass	2
27	N/A	–	–	–	–	
28	N/A	–	–	–	–	
40	N/A	–	–	–	–	–
41	24 * 24	96	40	0.75	Fiberglass	2
42	22 * 18	80	69	0	–	2
	12 * 12	48	8	0	–	2
	24 * 24	96	10	0	–	2
61	20 * 20	80	40	3	Fiberglass	2
100	N/A	–	–	–	–	2
101	N/A	–	–	–	–	–
102	20 * 20	80	10	0.5	Fiberglass	2
	12 * 16	56	65	0.75	Fiberglass	2
	10 * 10	40	50	0.75	Fiberglass	2
105	20 * 26	92	4	0	–	2
	20 * 26	92	80	2	Fiberglass	2
109	N/A	–	–	–	–	–
111	N/A	–	–	–	–	–
112	N/A	–	–	–	–	–
114	24 * 24	96	90	1	Fiberglass	2
	9 * 9	36	40	1	Fiberglass	2
116	12 * 14	52	11	0	–	2
	20 * 20	80	90	0	–	2
	11 * 11	44	40	0	–	2
117	N/A	–	–	–	–	2
118	24 * 24	96	90	0.5	Fiberglass	2
155	24 * 24	96	50	1.5	Fiberglass	2
	18 * 18	72	50	1	Fiberglass	2
	30 * 30	120	50	1.5	Fiberglass	2
178	24 * 24	96	10	0.5	Fiberglass	2
	18 * 18	72	10	0.5	Fiberglass	2
	24 * 24	96	10	0.5	Fiberglass	2
	50 * 8	116	65	1.5	Fiberglass	2
	60 * 8	136	65	1.5	Fiberglass	2
179	N/A	–	–	–	–	–
358	36 * 15	102	75	2	Fiberglass	2
	22 * 18	80	35	2	Fiberglass	2
	18 * 38	112	30	2	Fiberglass	2
	36 * 24	120	55	0	–	2
	18 * 80	196	10	0	–	2
360	N/Av	–	–	–	–	2
400	24 * 12	72	225	1	Fiberglass	2
522	N/A	–	–	–	–	–

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: DUCT AND PIPE INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 22-Jul-92
FILE: MDUCTPIPE.WK3
PREPARED BY: CMD
CHECKED BY: CEL

Energy cost:
Gas: $4.67 / MBtu
Electric: 0.0255 /KWH

EXISTING PIPE INSULATION CONDITION

BLDG#	PIPE DIA (in)	PIPE LENGTH (ft)	INSUL. THICK. (in)	k Btuh in/ ft²·°F	FLUID TEMP (°F)	AMB TEMP (°F)	Rc (F/Btuh)	SURFACE TEMP. (F/Btuh)	COND. R (F/Btuh)	CONV. R (F/Btuh)	TOTAL R (F/Btuh)	EXIST TOTAL LOSS (Btuh)	ANNUAL ENERGY LOSS (MBtu/yr)	ANNUAL ENERGY LOSS (KWH/yr)	ANNUAL ENERGY COST ($/yr)
41	3	50	0.5	0.26	140	50	1.59	88.62	2.11	1.59	3.70	1,216	7.10	–	$33.15
	2	50	0.5	0.26	140	50	2.14	87.60	2.98	2.14	5.12	880	5.14	–	$23.99
42	1.5	40	1	0.26	140	50	2.15	73.11	6.22	2.15	8.37	430	2.51	–	$11.72
61	2	100	1	0.26	140	50	1.86	74.05	5.09	1.86	6.95	1,295	7.56	–	$35.32
	3	90	1	0.26	140	50	1.46	75.24	3.75	1.46	5.21	1,553	9.07	–	$42.36
	2	40	1	0.29	255	50	1.46	99.72	4.56	1.46	6.03	1,361	7.95	–	$37.11
	4	50	1.5	0.29	255	50	0.90	90.11	3.69	0.90	4.58	2,237	13.06	–	$61.01
	3	60	1	0.29	255	50	1.15	102.24	3.36	1.15	4.51	2,725	15.91	–	$74.31
	2	10	0	0.29	255	50	–	–	–	–	–	3,220	18.80	–	$87.82
	1	10	0	0.29	255	50	–	–	–	–	–	1,880	10.98	–	$51.27
	2	70	1.5	0.29	255	50	1.30	86.27	6.03	1.30	7.33	1,957	11.43	–	$53.38
	1.5	40	0	0.29	255	50	–	–	–	–	–	10,520	61.44	–	$286.91
	3	40	1	0.29	255	50	1.15	102.24	3.36	1.15	4.51	1,816	10.61	–	$49.54
111	2	15	0	0.26	140	50	–	–	–	–	–	2,280	13.32	–	$62.18
	2	15	0.5	0.26	50	80	2.91	65.18	2.98	2.91	5.88	76	–	19.54	$0.50
109	2.5	50	1	0.26	140	50	1.64	74.73	4.32	1.64	5.95	756	4.41	–	$20.61
112	4	25	0.75	0.29	255	50	0.97	114.98	2.10	0.97	3.07	1,669	9.75	–	$45.52
	3	6	0	0.29	255	50	–	–	–	–	–	2,748	16.05	–	$74.95
	3.5	38	1	0.29	255	50	1.04	103.09	2.98	1.04	4.02	1,939	11.33	–	$52.89
	2	185	1	0.29	255	50	1.46	99.72	4.56	1.46	6.03	6,293	36.75	–	$171.63
	1.5	185	1	0.29	255	50	1.69	97.72	5.58	1.69	7.27	5,214	30.45	–	$142.21
117	2	25	0.5	0.26	50	80	2.91	65.18	2.98	2.91	5.88	127	–	32.56	$0.83
	2	15	0.5	0.26	140	50	2.91	94.45	2.98	2.02	5.00	270	1.58	–	$7.36
	2	4	0	0.29	255	50	–	–	–	–	–	1,288	7.52	–	$35.13
	2	10	1.25	0.26	140	50	1.74	70.38	5.96	1.74	7.70	117	0.68	–	$3.19
155	3.5	200	0	0.29	255	50	–	–	–	–	–	103,600	605.02	–	$2,825.46
	1	200	0	0.26	140	50	–	–	–	–	–	17,800	103.95	–	$485.46
360	2	50	0	0.26	140	50	–	–	–	–	–	7,600	44.38	–	$207.27
522	1.5	150	1	0.26	140	50	2.15	73.11	6.22	2.15	8.37	1,612	9.41	–	$43.96
												TOTALS:	1066.76	52.10	$4,983.08

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: DUCT AND PIPE INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 22-Jul-92
FILE: MDUCTPIPE.WK3
PREPARED BY: CMD
CHECKED BY: CEL

Energy cost:
Gas: $4.67 / MBtu
Electric: 0.0255 /KWH

NEW PIPE INSULATION CONDITION

BLDG#	PIPE DIA (in)	PIPE LENGTH (ft)	INSUL. THICK (in)	k Btuh in/ ft^2 F	FLUID TEMP. (F)	AMB TEMP (F)	Re (F/Btuh)	SURFACE TEMP (F/Btuh)	COND. R (F/Btuh)	CONV. R (F/Btuh)	TOTAL R (F/Btuh)	IMPROVED ENERGY LOSS (Btuh)	ANNUAL GAS LOSS (MBtu/yr)	ANNUAL ELECTRIC LOSS (KWH/yr)	ANNUAL ELECTRIC SAVINGS (KWH/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	ENERGY COST ($/yr)	ANNUAL SAVINGS ($/yr)
41	3	50	1.5	0.26	140	50	1.34	68.79	5.09	1.34	6.44	699	4.08	–	0	3.02	19.07	$14.08
	2	50	1.5	0.26	140	50	1.64	67.67	6.73	1.65	8.38	537	3.14	–	0	2.00	14.65	$9.34
42	1.5	40	1.5	0.26	140	50	1.86	66.83	8.07	1.86	9.93	363	2.12	–	0	0.39	9.89	$1.83
61	2	100	1.5	0.26	140	50	1.64	67.67	6.73	1.65	8.38	1,075	6.28	–	0	1.29	29.31	$6.02
	3	90	1.5	0.26	140	50	1.34	68.79	5.09	1.34	6.44	1,259	7.35	–	0	1.72	34.33	$8.03
	2	40	2.5	0.29	255	50	1.07	73.52	8.25	1.07	9.32	880	5.14	–	0	2.81	24.00	$13.11
	4	50	2.5	0.29	255	50	0.80	76.65	5.34	0.80	6.14	1,670	9.75	–	0	3.31	45.54	$15.47
	3	60	2.5	0.29	255	50	0.91	75.38	6.46	0.91	7.37	1,668	9.74	–	0	6.17	45.50	$28.80
	2	10	2.5	0.29	255	50	1.07	73.52	8.25	1.07	9.32	220	1.28	–	0	17.52	6.00	$81.82
	1	10	1.5	0.29	255	50	1.69	82.01	9.13	1.69	10.82	189	1.11	–	0	9.87	5.17	$46.11
	2	70	2.5	0.29	255	50	1.07	73.52	8.25	1.07	9.32	1,540	8.99	–	0	2.44	41.99	$11.38
	1.5	40	1.5	0.29	255	50	1.47	84.52	7.24	1.47	8.70	942	5.50	–	0	55.93	25.70	$261.21
	3	40	2.5	0.29	255	50	0.91	75.38	6.46	0.91	7.37	1,112	6.50	–	0	4.11	30.34	$19.20
111	2	15	1.5	0.26	140	50	1.64	67.67	6.73	1.65	8.38	161	0.94	–	0	12.37	4.40	$57.79
	2	15	1	0.26	50	80	2.49	70.14	5.09	2.49	7.58	59	–	15.16	4	0.00	0.39	$0.11
109	2.5	50	1.5	0.26	140	50	1.48	68.30	5.79	1.48	7.27	619	3.61	–	0	0.80	16.88	$3.73
112	4	25	3	0.29	255	50	0.76	72.83	6.03	0.76	6.79	755	4.41	–	0	5.34	20.58	$24.94
	3	6	2.5	0.29	255	50	0.91	75.38	6.46	0.91	7.37	167	0.97	–	0	15.07	4.55	$70.40
	3.5	38	3	0.29	255	50	0.80	72.29	6.58	0.80	7.38	1,056	6.17	–	0	5.16	28.80	$24.09
	2	185	1.5	0.29	140	50	1.61	68.93	6.03	1.61	7.64	2,179	12.72	–	0	24.03	59.42	$112.21
	1.5	185	2.5	0.29	255	50	1.17	72.21	9.66	1.17	10.83	3,502	20.45	–	0	10.00	95.50	$46.71
117	2	25	1	0.26	50	80	2.49	70.14	5.09	2.49	7.58	99	–	25.27	7	0.00	0.64	$0.19
	2	15	1.5	0.26	140	50	1.64	67.67	6.73	1.65	8.38	161	0.94	–	0	0.64	4.40	$2.97
	2	4	1.5	0.29	140	50	1.61	68.93	6.03	1.61	7.64	47	0.28	–	0	7.25	1.28	$33.84
	2	10	1.5	0.26	140	50	1.64	67.67	6.73	1.65	8.38	107	0.63	–	0	0.06	2.93	$0.26
155	3.5	250	2.5	0.29	255	50	0.85	76.07	5.84	0.85	6.69	7,655	44.71	–	0	560.32	208.78	$2,616.68
	1	250	1.5	0.26	140	50	2.14	65.63	10.18	2.14	12.32	1,826	10.66	–	0	93.29	49.79	$435.67
360	2	50	1.5	0.26	140	50	1.64	67.67	6.73	1.65	8.38	537	3.14	–	0	41.25	14.65	$192.62
522	1.5	150	1.5	0.26	140	50	1.86	66.83	8.07	1.86	9.93	1,360	7.94	–	0	1.47	37.09	$6.88
												TOTALS:	177.47	40.42	11.68	844.90	881.57	$3,945.97

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 1 – Duct Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 10-JUL-92
FILE: ECO-1DM.WK3
PREPARED BY: CMD
CHECKED BY: CEL

EXISTING DUCT INSULATION CONDITION

BLDG. #	DUCT PER. (in)	DUCT LENGTH (ft)	SURFACE AREA (ft²)	R OUTER FILM	R INNER FILM	R INS.	U	THERMAL COND. (Btu in/ h ft² F)	INS. THICK. (in)	LEAK CLASS	STATIC PRESS (in. w.g.)	LEAK RATE (cfm/ 100 ft²)	TOTAL LEAK (cfm)	WINTER DUCT TEMP (F)	WINTER AMB TEMP (F)	SUMMER DUCT TEMP (F)	SUMMER AMB TEMP (F)	DELTA ENTH
22	96	48	384	0.65	0.220	3.85	0.21	0.26	1	0	0.5	0.0	0.0	90	75	55	90	15.6
41	96	40	320	0.65	0.220	2.88	0.27	0.26	0.75	0	0.5	0.0	0.0	90	75	55	90	15.6
42	80	69	460	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	140.7	90	75	55	90	15.6
	48	8	32	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	9.8	90	75	55	90	15.6
	96	10	80	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	24.5	90	75	55	90	15.6
102	80	10	66.6667	0.65	0.220	1.92	0.36	0.26	0.5	0	0.5	0.0	0.0	90	75	55	90	15.6
	56	65	303.333	0.65	0.220	2.88	0.27	0.26	0.75	0	0.5	0.0	0.0	90	75	55	90	15.6
	40	50	166.667	0.65	0.220	2.88	0.27	0.26	0.75	0	0.5	0.0	0.0	90	75	55	90	15.6
105	92	4	30.6667	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	9.4	90	75	55	90	15.6
114	96	90	720	0.65	0.220	3.85	0.21	0.26	1	0	0.5	0.0	0.0	90	75	55	90	15.6
	36	40	120	0.65	0.220	3.85	0.21	0.26	1	0	0.5	0.0	0.0	90	75	55	90	15.6
116	52	11	47.6667	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	14.6	90	75	55	90	15.6
	80	90	600	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	183.5	90	75	55	90	15.6
	44	40	146.667	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	44.9	90	75	55	90	15.6
118	96	90	720	0.65	0.220	1.92	0.36	0.26	0.5	0	0.5	0.0	0.0	90	75	55	90	15.6
155	96	50	400	0.65	0.220	5.77	0.15	0.26	1.5	0	0.5	0.0	0.0	90	75	55	90	15.6
	72	50	300	0.65	0.220	3.85	0.21	0.26	1	0	0.5	0.0	0.0	90	75	55	90	15.6
	120	10	100	0.65	0.220	5.77	0.15	0.26	1.5	0	0.5	0.0	0.0	90	75	55	90	15.6
358	120	55	550	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	168.2	90	75	55	90	15.6
	196	10	163.333	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	50.0	90	75	55	90	15.6
400	72	225	1350	0.65	0.220	3.85	0.21	0.26	1	0	0.5	0.0	0.0	90	75	55	90	15.6

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

EMC PROJECT: #3105.000
DATE: 10-JUL-92
FILE: ECO-1DM.WK3
PREPARED BY: CMD
CHECKED BY: CEL

ECO: 1. DUCT INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXISTING DUCT INSULATION CONDITION

BLDG. #	ENERGY LOSSES: WINTER INSUL (Btu/h)	WINTER LEAK (Btu/h)	WINTER TOTAL (Btu/h)	SUMMER INSUL (kW)	SUMMER LEAK (kW)	SUMMER TOTAL (kW)	ANNUAL GAS (MBtu/yr)	ANNUAL ELECTRIC (kW/yr)
22	1628.4	--	1628.4	0.17	--	0.17	7.1	727.7
41	1704.6	--	1704.6	0.17	--	0.17	7.5	761.7
42	10574.7	3095.7	13670.4	1.08	0.58	1.65	59.9	7247.9
	735.6	215.3	951.0	0.08	0.04	0.12	4.2	504.2
	1839.1	538.4	2377.5	0.19	0.10	0.29	10.4	1260.5
102	477.4	--	477.4	0.05	--	0.05	2.1	213.3
	1615.8	--	1615.8	0.16	--	0.16	7.1	722.0
	887.8	--	887.8	0.09	--	0.09	3.9	396.7
105	705.0	206.4	911.4	0.07	0.04	0.11	4.0	483.2
114	3053.3	--	3053.3	0.31	--	0.31	13.4	1364.4
	508.9	--	508.9	0.05	--	0.05	2.2	227.4
116	1095.8	320.8	1416.6	0.11	0.06	0.17	6.2	751.0
	13793.1	4037.8	17830.9	1.41	0.75	2.16	78.1	9453.8
	3371.6	987.0	4358.7	0.34	0.18	0.53	19.1	2310.9
118	5155.6	--	5155.6	0.53	--	0.53	22.6	2303.9
155	1205.0	--	1205.0	0.12	--	0.12	5.3	538.5
	1272.2	--	1272.2	0.13	--	0.13	5.6	568.5
	301.2	--	301.2	0.03	--	0.03	1.3	134.6
358	12643.7	3701.3	16345.0	1.29	0.69	1.98	71.6	8666.0
	3754.8	1099.2	4854.0	0.38	0.20	0.59	21.3	2573.5
400	5725.0	--	5725.0	0.58	--	0.58	25.1	2558.3

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 1. DUCT INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE:
FILE: ECO-1DM.WK3
PREPARED BY: CMD
CHECKED BY: CEL

UNIT CONST $3.05 / ft²

NEW DUCT INSULATION CONDITION

BLDG.	IMPROVED ENERGY LOSSES								ANNUAL ENERGY SAVINGS		TOTAL CONST COST
	WINTER			SUMMER			ANNUAL				
#	INSUL (Btu/h)	LEAK (Btu/h)	TOTAL (Btu/h)	INSUL (kW)	LEAK (kW)	TOTAL (kW)	GAS (MBtu/yr)	ELECTRIC (kW/yr)	GAS (MBtu/yr)	ELECTRIC (kW/yr)	($)
22	897.0	--	897.0	0.04	--	0.04	3.9	171.8	3.2	555.9	$1,171.20
41	747.5	--	747.5	0.03	--	0.03	3.3	143.2	4.2	618.6	$976.00
42	1074.5	1547.8	2622.3	0.05	0.29	0.33	11.5	1467.0	48.4	5780.9	$1,403.00
	74.7	107.7	182.4	0.00	0.02	0.02	0.8	102.0	3.4	402.2	$97.60
	186.9	269.2	456.1	0.01	0.05	0.06	2.0	255.1	8.4	1005.4	$244.00
TOTAL									60.2	7188.5	$1,744.60
102	155.7	--	155.7	0.01	--	0.01	0.7	29.8	1.4	183.5	$203.33
	708.5	--	708.5	0.03	--	0.03	3.1	135.7	4.0	586.4	$925.17
	389.3	--	389.3	0.02	--	0.02	1.7	74.6	2.2	322.2	$508.33
TOTAL									7.6	1092.0	$1,636.83
105	71.6	103.2	174.8	0.00	0.02	0.02	0.8	97.8	3.2	385.4	$93.53
114	1681.8	--	1681.8	0.07	--	0.07	7.4	322.1	6.0	1042.4	$2,196.00
	280.3	--	280.3	0.01	--	0.01	1.2	53.7	1.0	173.7	$366.00
TOTAL									7.0	1216.1	$2,562.00
116	111.3	160.4	271.7	0.00	0.03	0.03	1.2	152.0	5.0	599.0	$145.38
	1401.5	2018.9	3420.4	0.06	0.38	0.44	15.0	1913.4	63.1	7540.3	$1,830.00
	342.6	493.5	836.1	0.01	0.09	0.11	3.7	467.7	15.4	1843.2	$447.33
TOTAL									83.6	9982.6	$2,422.72
118	1681.8	--	1681.8	0.07	--	0.07	7.4	322.1	15.2	1981.8	$2,196.00
155	934.3	--	934.3	0.04	--	0.04	4.1	178.9	1.2	359.5	$1,220.00
	700.7	--	700.7	0.03	--	0.03	3.1	134.2	2.5	434.3	$915.00
	233.6	--	233.6	0.01	--	0.01	1.0	44.7	0.3	89.9	$305.00
TOTAL									4.0	883.7	$2,440.00
358	1284.7	1850.7	3135.4	0.06	0.34	0.40	13.7	1754.0	57.9	6912.0	$1,677.50
	381.5	549.6	931.1	0.02	0.10	0.12	4.1	520.9	17.2	2052.6	$498.17
TOTAL									75.0	8964.6	$2,175.67
400	3153.4	--	3153.4	0.14	--	0.14	13.8	603.9	11.3	1954.4	$4,117.50

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 1 – Duct Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE:
FILE: ECO-1DM.WK3
PREPARED BY: CMD
CHECKED BY: CEL

UNIT CONST COST: $3.05 / ft²

NEW DUCT INSULATION CONDITION

														WINTER		SUMMER		
BLDG. #	DUCT PER. (in)	DUCT LENGTH (ft)	SURFACE AREA (ft²)	R OUTER FILM	R INNER FILM	R INS.	U	THERMAL COND. (Btu in/ h ft² F)	INS. THICK. (in)	LEAK CLASS	STATIC PRESS (in. w.g.)	LEAK RATE (cfm/ 100 ft²)	TOTAL LEAK (cfm)	DUCT TEMP (F)	AMB TEMP (F)	DUCT TEMP (F)	AMB TEMP (F)	DELTA ENTH
22	96	48	384	0.65	0.220	7.69	0.12	0.26	2	0	0.5	0.0	0.0	90	75	55	90	15.6
41	96	40	320	0.65	0.220	7.69	0.12	0.26	2	0	0.5	0.0	0.0	90	75	55	90	15.6
42	80	69	460	0.65	0.220	7.69	0.12	0.26	2	24	0.5	15.3	70.4	90	75	55	90	15.6
	48	8	32	0.65	0.220	7.69	0.12	0.26	2	24	0.5	15.3	4.9	90	75	55	90	15.6
	96	10	80	0.65	0.220	7.69	0.12	0.26	2	24	0.5	15.3	12.2	90	75	55	90	15.6
TOTAL																		
102	80	10	66.6667	0.65	0.220	7.69	0.12	0.26	2	0	0.5	0.0	0.0	90	75	55	90	15.6
	56	65	303.333	0.65	0.220	7.69	0.12	0.26	2	0	0.5	0.0	0.0	90	75	55	90	15.6
	40	50	166.667	0.65	0.220	7.69	0.12	0.26	2	0	0.5	0.0	0.0	90	75	55	90	15.6
TOTAL																		
105	92	4	30.6667	0.65	0.220	7.69	0.12	0.26	2	24	0.5	15.3	4.7	90	75	55	90	15.6
114	96	90	720	0.65	0.220	7.69	0.12	0.26	2	0	0.5	0.0	0.0	90	75	55	90	15.6
	36	40	120	0.65	0.220	7.69	0.12	0.26	2	0	0.5	0.0	0.0	90	75	55	90	15.6
TOTAL																		
116	52	11	47.6667	0.65	0.220	7.69	0.12	0.26	2	24	0.5	15.3	7.3	90	75	55	90	15.6
	80	90	600	0.65	0.220	7.69	0.12	0.26	2	24	0.5	15.3	91.8	90	75	55	90	15.6
	44	40	146.667	0.65	0.220	7.69	0.12	0.26	2	24	0.5	15.3	22.4	90	75	55	90	15.6
TOTAL																		
118	96	90	720	0.65	0.220	7.69	0.12	0.26	2	0	0.5	0.0	0.0	90	75	55	90	15.6
155	96	50	400	0.65	0.220	7.69	0.12	0.26	2	0	0.5	0.0	0.0	90	75	55	90	15.6
	72	50	300	0.65	0.220	7.69	0.12	0.26	2	0	0.5	0.0	0.0	90	75	55	90	15.6
	120	10	100	0.65	0.220	7.69	0.12	0.26	2	0	0.5	0.0	0.0	90	75	55	90	15.6
TOTAL																		
358	120	55	550	0.65	0.220	7.69	0.12	0.26	2	24	0.5	15.3	84.1	90	75	55	90	15.6
	196	10	163.333	0.65	0.220	7.69	0.12	0.26	2	24	0.5	15.3	25.0	90	75	55	90	15.6
TOTAL																		
400	72	225	1350	0.65	0.220	7.69	0.12	0.26	2	0	0.5	0.0	0.0	90	75	55	90	15.6

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097	EFFECTIVE PRICING DATE APR 92	DATE PREPARED 22-Apr-92	
PROJECT Ft. McPherson & Ft. Gillem ESOS Study	[X] CODE A [ ] CODE B [ ] CODE C	DRAWING NO.	SHT OF
LOCATION Ft. McPherson & Ft Gillem	[ ] OTHER	ESTIMATOR RMG	CHECKED BY CEL

PIPE INSULATION	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
'1.5" INSULATION, FITS 2" PIPE	1	LF	0.084	0.084	$20.88	$1.75			$2.82	$2.82	$4.57		
'2" INSULATION, FITS 1" PIPE	1	LF	0.08	0.08	$20.88	$1.67			$3.59	$3.59	$5.26		
'1.5" INSULATION, FITS 3" PIPE	1	LF	0.094	0.094	$20.88	$1.96			$3.20	$3.20	$5.16		
'1.5" INSULATION, FITS 1.5" PIPE	1	LF	0.08	0.08	$20.88	$1.67			$2.60	$2.60	$4.27		
'1.5" INSULATION, FITS 4" PIPE	1	LF	0.114	0.114	$20.88	$2.38			$3.65	$3.65	$6.03		
'2.5" INSULATION, FITS 2" PIPE	1	LF	0.093	0.093	$20.88	$1.94			$3.19	$3.19	$5.13		
'2.5" INSULATION, FITS 4" PIPE	1	LF	0.133	0.133	$20.88	$2.78			$4.36	$4.36	$7.14		
2.5" INSULATION, FITS 3" PIPE	1	LF	0.106	0.106	$20.88	$2.21			$3.91	$3.91	$6.12		
1.5" INSULATION, FITS 1" PIPE	1	LF	0.076	0.076	$20.88	$1.59			$2.29	$2.29	$3.88		
1" INSULATION, FITS 2" PIPE	1	LF	0.08	0.08	$20.88	$1.67			$1.58	$1.58	$3.25		
3" INSULATION, FITS 4" PIPE	1	LF	0.144	0.144	$20.88	$3.01			$5.55	$5.55	$8.56		
3" INSULATION, FITS 3.5" PIPE	1	LF	0.121	0.121	$20.88	$2.53			$4.71	$4.71	$7.24		
2.5" INSULATION, 1.5" PIPE	1	LF	0.088	0.088	$20.88	$1.84			$3.19	$3.19	$5.03		
SUBTOTAL						$27.00				$44.64	$71.64		
OVERHEAD, BOND	15%					$4.05				$6.70	$10.75		
PROFIT	10%					$2.70				$4.46	$7.16		
COST SUB-TOTAL						$33.75				$55.80	$89.55		
CONTINGENCY	15%					$5.06				$8.37	$13.43		
TOTAL						$38.81				$64.17	$102.98		

DA FORM 5418-R, APR 85

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

X CODE A CODE B CODE C OTHER

EFFECTIVE PRICING DATE APR 92

DATE PREPARED 14-Jul-92

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

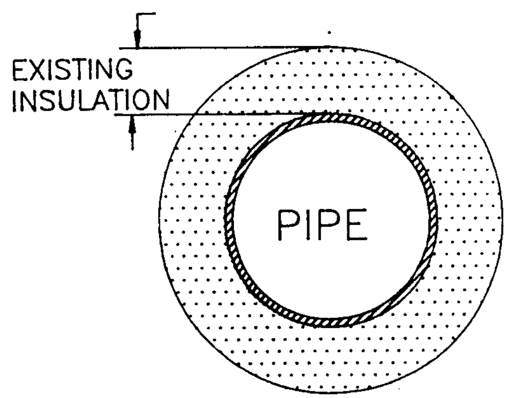
DRAWING NO.

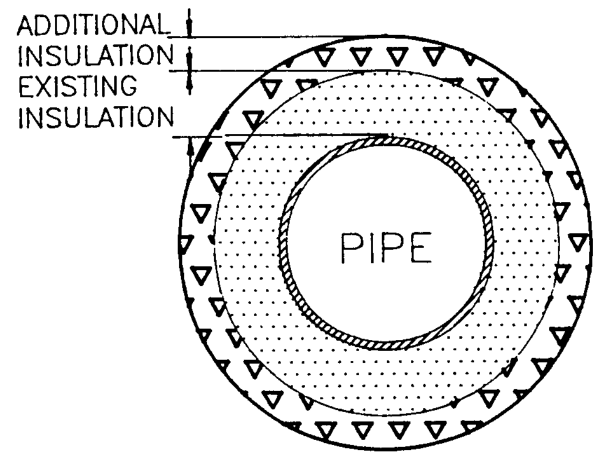
SHT OF

ESTIMATOR RMG

CHECKED BY CEL

DUCT INSULATION	Quantity			LABOR			EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
INSULATE DUCTS													
FLEXIBLE BLANKET TYPE	1	SF	0.058	0.058	$20.88	$1.21			$0.90	$0.90	$2.11		
FIBERGLASS INSULATION (2")													
JOINT SEALING													
SUBTOTAL				$0.06		$1.21				$0.90	$2.11		
OVERHEAD, BOND	15%			$0.01		$0.18				$0.14	$0.32		
PROFIT	10%			$0.01		$0.12				$0.09	$0.21		
COST SUB-TOTAL				$0.07		$1.51				$1.13	$2.64		
CONTINGENCY	15%			$0.01		$0.23				$0.17	$0.40		
TOTAL				$0.08		$1.74				$1.29	$3.03		





ADDITIONAL INSULATION

FLUID	PIPE SIZE (inches)				
	0.25–1.00	1.25–2.00	2.25–3.00	3.25–4.00	4.25–5.00
CHILLED WATER PIPES					
Fiberglass	0.50	0.75	1.00	1.00	1.00
Rubber	1.00	1.00	1.00	1.00	1.00
Foam	1.50	1.50	1.50	2.00	2.00
HOT WATER PIPES (Also Condensate)					1.50
Fiberglass	1.50	1.50	1.50	1.50	1.50
Rubber	1.50	1.50	1.50	2.50	2.50
Foam	1.50	1.50	1.50	2.50	2.50
STEAM PIPES					
Fiberglass	2.00	2.50	2.50	3.00	3.50
Rubber	1.50	1.50	1.50	2.50	2.50
Foam	1.50	1.50	1.50	2.50	2.50
DUCTS	All Sizes				
	2" Fiberglass				

APPENDIX C-2

INSULATED GLASS

INSULATED GLASS SAMPLE CALCULATION, ECO #2
BUILDING 111

Given:

# of Windows	= 24 windows	- from bldg plans / survey notes
Window Perimeter	= 384 ft	- from bldg plans / survey notes
Window Area	= 380 ft^2	- from bldg plans / survey notes
Gas Savings Factor	= 0.0024 MBtu / ft^2	- from Bldg 100 simulation
Electric Savings Factor	= 0.13 kWh / ft^2	- from Bldg 100 simulation
Demand Savings Factor	= 0.0 kW	- from Bldg 100 simulation
Gas Cost	= $4.67 / MBtu	- from utility rate analysis
Electric Cost	= $0.0255 / kWh	- from utility rate analysis
Demand Cost	= $8.85 / kW	- from utility rate analysis

Peak Demand Savings:

(380 ft^2)*(0.0 kW / UA) = 0.0 kW

Annual Energy Savings:

- Gas: (380 ft^2)*(0.0024 MBtu / ft^2) = 0.9 MBtu
- Electric: (380 ft^2)*(0.13 kWh / ft^2) = 49 kWh

Annual Cost Savings:

(0.9 MBtu)*($4.67 / MBtu) + (49 kWh)*($0.0255 / kWh) + (0.0 kW)*($8.85 / kW)*(4 + .95 * 8) = $6 / yr

Estimated Construction Cost:

$11.83 / each window demolition	- from engineer's cost estimate
$26.89 / ft of perimeter	- from engineer's cost estimate

($11.83 / ea)*(24 win) + ($26.89 / ft)*(384 ft) = $10,610

$10,610 + ($10,610 * .055 SIOH) + ($10,610 * .06 DESIGN) = $11,830

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 2 – Insulated Glass

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 21-Jul-92
FILE: ECO-2.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	23.77 UPWG
Electric Savings	$0.0255 / kWh	15.61 UPWE
Demand Savings	$8.85 / kW	14.53 UPW

Economic Life: 25 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON-ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
040	1	920	60	63	$302	$123	$0	$425	$40,927	0.2	96
056	2	1,276	83	87	$419	$170	$0	$589	$69,343	0.2	118
058	2	1,276	83	87	$419	$170	$0	$589	$69,343	0.2	118
060	2	1,549	101	106	$509	$206	$0	$715	$87,834	0.2	123
155	1	28	6	6	$27	$60	$0	$87	$7,107	0.2	82
184	4	1,925	41	48	$241	$411	$0	$651	$67,390	0.2	103
109	1	408	7	8	$43	$57	$0	$99	$14,294	0.1	144
042	0	41	1	1	$5	$0	$0	$5	$9,193	0.0	2009
061	0	77	1	2	$9	$0	$0	$9	$17,314	0.0	2018
101	0	130	2	3	$15	$0	$0	$15	$30,891	0.0	2125
102	0	23	0	1	$3	$0	$0	$3	$5,872	0.0	2259
111	0	49	1	1	$6	$0	$0	$6	$11,830	0.0	2145
112	0	49	1	1	$6	$0	$0	$6	$11,830	0.0	2145
114	0	49	1	1	$6	$0	$0	$6	$11,830	0.0	2145
116	0	49	1	1	$6	$0	$0	$6	$11,830	0.0	2145
117	0	49	1	1	$6	$0	$0	$6	$11,830	0.0	2145
118	0	49	1	1	$6	$0	$0	$6	$11,830	0.0	2145
120	0	49	1	1	$6	$0	$0	$6	$11,830	0.0	2145
121	0	49	1	1	$6	$0	$0	$6	$11,830	0.0	2145
122	0	49	1	1	$6	$0	$0	$6	$11,830	0.0	2145
124	0	49	1	1	$6	$0	$0	$6	$11,830	0.0	2145
126	0	49	1	1	$6	$0	$0	$6	$11,830	0.0	2145

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 2 – Insulated Glass

CLIENT CONTRACT NO: DACA21–91–C–0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15–APR–92
FILE: EC0–2.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG #	# WIN	WIN PERIM (ft)	WIN AREA (ft²)	DEMAND SAVINGS (kW/ft²)	ELECTRIC SAVINGS (kWh/ft²)	GAS SAVINGS (MBtu/ft²)	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	UNIT DEMO COST ($/ea)	UNIT CONST COST ($/ft)	TOTAL CONST COST ($)
040	66	1,336	1,613	0.00074	0.57	0.037	1.19	920	59.7	$11.83	$26.89	$36,706
042	15	300	315	0	0.13	0.0024	0	41	0.8	$11.83	$26.89	$8,244
056	120	2,260	2,238	0.00074	0.57	0.037	1.66	1276	82.8	$11.83	$26.89	$62,191
058	120	2,260	2,238	0.00074	0.57	0.037	1.66	1276	82.8	$11.83	$26.89	$62,191
060	152	2,863	2,717	0.00074	0.57	0.037	2.01	1549	100.5	$11.83	$26.89	$78,775
061	31	564	591	0	0.13	0.0024	0	77	1.4	$11.83	$26.89	$15,528
101	53	1,007	1,001	0	0.13	0.0024	0	130	2.4	$11.83	$26.89	$27,705
102	11	191	179	0	0.13	0.0024	0	23	0.4	$11.83	$26.89	$5,266
109	29	464	459	0.0012	0.89	0.015	0.55	408	6.9	$11.83	$26.89	$12,820
111	24	384	380	0	0.13	0.0024	0	49	0.9	$11.83	$26.89	$10,610
112	24	384	380	0	0.13	0.0024	0	49	0.9	$11.83	$26.89	$10,610
114	24	384	380	0	0.13	0.0024	0	49	0.9	$11.83	$26.89	$10,610
116	24	384	380	0	0.13	0.0024	0	49	0.9	$11.83	$26.89	$10,610
117	24	384	380	0	0.13	0.0024	0	49	0.9	$11.83	$26.89	$10,610
118	24	384	380	0	0.13	0.0024	0	49	0.9	$11.83	$26.89	$10,610
120	24	384	380	0	0.13	0.0024	0	49	0.9	$11.83	$26.89	$10,610
121	24	384	380	0	0.13	0.0024	0	49	0.9	$11.83	$26.89	$10,610
122	24	384	380	0	0.13	0.0024	0	49	0.9	$11.83	$26.89	$10,610
124	24	384	380	0	0.13	0.0024	0	49	0.9	$11.83	$26.89	$10,610
126	24	384	380	0	0.13	0.0024	0	49	0.9	$11.83	$26.89	$10,610
155	16	230	188	0.0031	0.15	0.03	0.58	28	5.6	$11.83	$26.89	$6,374
184	102	1,989	2,182	0.0018	0.88	0.019	4	1925	41.0	$11.83	$29.78	$60,439

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 2 – Insulated Glass

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 21-APR-92
FILE: EC0-2.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG #	# WIN	LENGTH (in)	WIDTH (in)	AREA (ft^2)	PERIM (ft)	TOTAL AREA (ft^2)	TOTAL PERIM (ft)	TOTAL # WIN
040	48	73	40	973	904	1613	1336	66
	18	80	64	640	432			
042	15	84	36	315	300	315	300	15
056	120	79	34	2238	2260	2238	2260	120
058	120	79	34	2238	2260	2238	2260	120
060	152	79	34	2717	2863	2717	2863	152
061	10	85	40	236	208	591	564	31
	5	85	40	118	104			
	3	63	39	51	51			
	2	53	44	32	32			
	2	63	39	34	34			
	3	63	39	51	51			
	3	63	31	41	47			
	3	36	36	27	36			
101	53	80	34	1001	1007	1001	1007	53
102	8	78	33	143	148	179	191	11
	3	54	32	36	43			
109	29	53	43	459	464	459	464	29
111	24	53	43	380	384	380	384	24
112	24	53	43	380	384	380	384	24
114	24	53	43	380	384	380	384	24
116	24	53	43	380	384	380	384	24
117	24	53	43	380	384	380	384	24
118	24	53	43	380	384	380	384	24
120	24	53	43	380	384	380	384	24
121	24	53	43	380	384	380	384	24
122	24	53	43	380	384	380	384	24
124	24	53	43	380	384	380	384	24
126	24	53	43	380	384	380	384	24
155	3	40	30	25	35	188	230	16
	2	60	30	25	30			
	5	60	30	63	75			
	1	60	30	13	15			
	5	60	30	63	75			
184	102	77	40	2182	1989	2182	1989	102

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

X CODE A ☐ CODE B ☐ CODE C ☐ OTHER ______

EFFECTIVE PRICING DATE APR 92

DATE PREPARED 15-Apr-92

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

DRAWING NO.

SHT OF

ESTIMATOR RMG

CHECKED BY

ECO 2 – Insulated Glass, Aluminum	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
ALUMINUM DEMOLITION	1	EA	0.727	0.727	$18.53	$13.47					$13.47		
SUBTOTAL						$13.47					$13.47		
OVERHEAD, BOND	15%					$2.02					$2.02		
PROFIT	10%					$1.35					$1.35		
COST SUB-TOTAL						$16.84					$16.84		
CONTINGENCY	15%					$2.53					$2.53		
TOTAL						$19.37					$19.37		
ALUMINUM CASEMENT (awning)	1	LF	0.160	0.160	$18.53	$2.96			$19.00	$19.00	$21.96		
SUBTOTAL						$2.96					$21.96		
OVERHEAD, BOND	15%					$0.44					$3.29		
PROFIT	10%					$0.30					$2.20		
COST SUB-TOTAL						$3.71					$27.46		
CONTINGENCY	15%					$0.56					$4.12		
TOTAL						$4.26					$31.57		

COST ESTIMATE ANALYSIS

PROJECT	Ft. McPherson & Ft. Gillem ESOS Study
LOCATION	Ft. McPherson & Ft Gillem
INVITATION NO./CONTRACT NO.	DACA 21-91-C-0097
X CODE A / CODE B / CODE C / OTHER	
EFFECTIVE PRICING DATE	APR 92
DRAWING NO.	
ESTIMATOR	RMG
DATE PREPARED	15-Apr-92
SHT OF	
CHECKED BY	

ECO 2 – Insulated Glass, Wood	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
WOOD DEMOLITION	1	EA	0.444	0.444	$18.53	$8.23					$8.23		
SUBTOTAL						$8.23					$8.23		
OVERHEAD, BOND	15%					$1.23					$1.23		
PROFIT	10%					$0.82					$0.82		
COST SUB-TOTAL						$10.28					$10.28		
CONTINGENCY	15%					$1.54					$1.54		
TOTAL						$11.83					$11.83		
WOOD CASEMENT	1	LF	0.200	0.200	$18.53	$3.71			$17.00	$17.00	$20.71		
SUBTOTAL						$3.71					$20.71		
OVERHEAD, BOND	15%					$0.56					$3.11		
PROFIT	10%					$0.37					$2.07		
COST SUB-TOTAL						$4.63					$25.88		
CONTINGENCY	15%					$0.69					$3.88		
TOTAL						$5.33					$29.76		
WOOD SLIDING (double hung)	1	LF	0.2	0.200	$18.53	$3.71			$15.00	$15.00	$18.71		
SUBTOTAL						$3.71					$18.71		
OVERHEAD, BOND	15%					$0.56					$2.81		
PROFIT	10%					$0.37					$1.87		
COST SUB-TOTAL						$4.63					$23.38		
CONTINGENCY	15%					$0.69					$3.51		
TOTAL						$5.33					$26.89		

DA FORM 5418-R, APR 85

APPENDIX C-3

WEATHERSTRIPPING AND CAULKING

LIFE CYCLE COST ANALYSIS SUMMARY   STUDY: MECO25
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)   LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-3 WEATHER STRIPPING & CULK
ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	1332.
B. SIOH	$	74.
C. DESIGN COST	$	80.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	1486.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	0.	$ 1.	15.61	9.
B. DIST	$ .00	0.	$ 0.	21.66	0.
C. RESID	$ .00	0.	$ 0.	26.51	0.
D. NAT G	$ 4.67	1.	$ 5.	23.77	111.
E. COAL	$ .00	0.	$ 0.	16.06	0.
F. TOTAL		1.	$ 5.		$ 120.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 234.
(1) DISCOUNT FACTOR (TABLE A) 14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 3400.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 3400.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 40.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) .11
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 239.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 3520.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 2.37
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 6.21

WEATHERSTRIPPING & CAULKING SAMPLE CALCULATION, ECO #3
BUILDING 111

Given:

Stack coefficient(A)	= 0.016	-from ASHRAE Table F 23.7
Wind coefficient(B)	= 0.0039	-from ASHRAE Table F 23.7
Avg. temperature diff.	= 72 - 55 = 17°F	-from Atlanta weather data
Avg. wind speed	= 12.65 mph	-from Atlanta weather data
# of windows	= 24 windows	-from bldg plans / survey notes
Window area	= 380 ft^2	-from bldg plans / survey notes
Exist. window leakage coef.	= 0.052 in^2/ft^2	-from ASHRAE Table F 23.3
Exist. frame leakage coef.	= 0.093 in^2/ft^2	-from ASHRAE Table F 23.3
Imp. window leakage coef.	= 0.026 in^2/ft^2	-from ASHRAE Table F 23.3
Imprv. frame leakage coef.	= 0.019 in^2/ft^2	-from ASHRAE Table F 23.3
# of doors	= 3 doors	-from bldg plans / survey notes
Door area	= 52 ft^2	-from bldg plans / survey notes
Exist. door leakage coef.	= 0.157 in^2/ft^2	-from ASHRAE Table F 23.3
Exist. frame leakage coef.	= 0.072 in^2/ft^2	-from ASHRAE Table F 23.3
Imprv. door leakage coef.	= 0.114 in^2/ft^2	-from ASHRAE Table F 23.3
Imprv. frame leakage coef.	= 0.0143 in^2/ft^2	-from ASHRAE Table F 23.3
Total door/win perimeter	= 440 ft	-from bldg plans / survey notes
Gas savings factor	= 0.025 MBtu/cfm	-from Bldg 100 simulation
Electric savings factor	= 5.8 kWh/cfm	-from Bldg 100 simulation
Demand savings factor	= 0.0 kW/cfm	-from Bldg 100 simulation
Gas Cost	= $4.67/MBtu	-from utility rate analysis
Electric Cost	= $0.0255/kWh	-from utility rate analysis
Demand Cost	= $8.85/kW	-from utility rate analysis

Existing Effective Leakage Area:

$(.052 + .093\ in^2/ft^2)*(380\ ft^2) + (.157 + .072\ in^2/ft^2)*(52\ ft^2)$
$= 66.9\ in^2$

Existing Window / Door Infiltration:

$66.9*(0.016*(17) + .0039*(12.65^2))$^1/2 = 63 cfm

Improved Effective Leakage Area:

$(.026 + .019\ in^2/ft^2)*(380\ ft^2) + (.114 + .0143\ in^2/ft^2)*(52\ ft^2)$
$= 23.7\ in^2$

Improved Window / Door Infiltration:

$23.7*(0.016*(17) + .0039*(12.65^2))$^1/2 = 22 cfm

Delta infiltration:

63 - 22 = 41 cfm

Peak Demand Savings:

(41 cfm)*(0.0 kW / cfm) = 0.0 kW

Annual Energy Savings:

- Gas:	(41 cfm)*(0.025 MBtu / cfm)	= 1.02 MBtu
- Electric:	(41 cfm)*(5.8 kWh / cfm)	= 187 kWh

Annual Cost Savings:

(1.02 MBtu)*($4.67 / MBtu) + (187 kWh)*($0.0255 / kWh) + (0.0 kW)*($8.85 / kW)*(4 + 0.95 * 8) = $10 / yr

Estimated Construction Cost:

$53.00 / window	-from engineer's cost estimate
$114.17 / door	-from engineer's cost estimate
$1.18 / ft of perimeter	-from engineer's cost estimate

($53.00 / ea)*(24 win) + ($114.17 / ea)*(3 doors) + ($1.18/ ft)*(440 ft) = $2,133

$2,133 + ($2,133 * .055 SIOH) + ($2,133 * .06 DESIGN) = $2,378

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 3 – Weatherstripping & Caulking

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 17-Jul-92
FILE: ECO-3.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	23.77 UPWG
Electric Savings	$0.0255 / kWh	15.61 UPWE
Demand Savings	$8.85 / kW	14.53 UPW

Economic Life: 25 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON-ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
155	2	22	1	1	$5	$234	$0	$240	$1,485	2.4	6.2
TOTAL	2	22	1	1	$5	$234	$0	$240	$1,485	2.4	6.2
056	1	413	16	17	$84	$91	$0	$174	$10,779	0.3	62
058	1	413	16	17	$84	$91	$0	$174	$14,053	0.2	81
060	1	470	18	19	$95	$103	$0	$199	$3,942	0.9	20
061	0	326	2	3	$17	$0	$0	$17	$2,424	0.1	146
101	0	565	3	5	$29	$0	$0	$29	$4,914	0.1	171
105	0	112	1	1	$6	$0	$0	$6	$1,226	0.1	216
109	0	199	1	2	$10	$0	$0	$10	$2,779	0.1	274
111	0	187	1	2	$10	$0	$0	$10	$2,378	0.1	250
112	0	153	1	1	$8	$0	$0	$8	$1,907	0.1	245
114	0	180	1	2	$9	$0	$0	$9	$2,227	0.1	243
116	0	132	1	1	$7	$0	$0	$7	$1,737	0.1	258
117	0	187	1	2	$10	$0	$0	$10	$2,378	0.1	250
118	0	187	1	2	$10	$0	$0	$10	$2,378	0.1	250
120	0	187	1	2	$10	$0	$0	$10	$2,378	0.1	250
121	0	105	1	1	$5	$0	$0	$5	$1,417	0.1	265
122	0	187	1	2	$10	$0	$0	$10	$2,378	0.1	250
124	0	165	1	1	$8	$0	$0	$8	$2,334	0.1	277
126	0	165	1	1	$8	$0	$0	$8	$2,334	0.1	277
022	0	0	0	0	$2	$0	$0	$2	$5,551	0.0	3609
027	0	0	1	1	$3	$0	$0	$3	$5,839	0.0	2185
028	0	0	1	1	$3	$0	$0	$3	$5,839	0.0	2185
040	0	22	1	1	$4	$5	$0	$9	$6,740	0.0	722
041	0	139	1	1	$7	$0	$0	$7	$4,369	0.0	618
100	0	23	0	0	$1	$0	$0	$1	$2,424	0.0	2071
522	0	4	0	0	$1	$0	$0	$1	$3,655	0.0	2957
358	0	(4)	(0)	(0)	($0)	$0	$0	($0)	No Savings		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 3 – Weatherstripping & Caulking

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-APR-92
FILE: ECO-3.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG #	TOTAL PERIM (ft)	# WIN	# DOORS	DELTA INFIL (cfm)	DEMAND SAVINGS (kW/cfm)	ELECTRIC SAVINGS (kWh/cfm)	GAS SAVINGS (MBtu/cfm)	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	UNIT CONST COST ($/ft)	UNIT CONST COST ($/win)	UNIT CONST COST ($/door)	CONST COST ($)
022	957	64	4	6	0	0.0037	0.052	0	0	0.33	$1.18	$53.00	$114.17	$4,978
027	1059	58	8	11	0	0.0037	0.052	0	0	0.57	$1.18	$53.00	$114.17	$5,237
028	1059	58	8	11	0	0.0037	0.052	0	0	0.57	$1.18	$53.00	$114.17	$5,237
040	1481	66	7	16	0.003	1.4	0.053	0.05	22	0.84	$1.18	$53.00	$114.17	$6,045
041	906	43	5	30	0	4.6	0.025	0	139	0.75	$1.18	$53.00	$114.17	$3,919
056	2416	120	4	295	0.003	1.4	0.053	0.89	413	15.64	$1.18	$53.00	$114.17	$9,668
058	2416	120	4	295	0.003	1.4	0.053	0.89	413	15.64	$1.18	$53.00	$114.17	$9,668
060	2983	152	9	336	0.003	1.4	0.053	1.01	470	17.81	$1.18	$53.00	$114.17	$12,603
061	733	31	9	71	0	4.6	0.025	0	326	1.77	$1.18	$53.00	$114.17	$3,535
100	422	23	4	5	0	4.6	0.025	0	23	0.13	$1.18	$53.00	$114.17	$2,174
101	1064	53	3	123	0	4.6	0.025	0	565	3.07	$1.18	$53.00	$114.17	$4,407
105	102	12	3	24	0	4.6	0.025	0	112	0.61	$1.18	$53.00	$114.17	$1,099
109	519	29	3	43	0	4.6	0.025	0	199	1.08	$1.18	$53.00	$114.17	$2,492
111	440	24	3	41	0	4.6	0.025	0	187	1.02	$1.18	$53.00	$114.17	$2,133
112	357	20	2	33	0	4.6	0.025	0	153	0.83	$1.18	$53.00	$114.17	$1,710
114	421	24	2	39	0	4.6	0.025	0	180	0.98	$1.18	$53.00	$114.17	$1,997
116	312	16	3	29	0	4.6	0.025	0	132	0.72	$1.18	$53.00	$114.17	$1,558
117	440	24	3	41	0	4.6	0.025	0	187	1.02	$1.18	$53.00	$114.17	$2,133
118	440	24	3	41	0	4.6	0.025	0	187	1.02	$1.18	$53.00	$114.17	$2,133
120	440	24	3	41	0	4.6	0.025	0	187	1.02	$1.18	$53.00	$114.17	$2,133
121	248	12	3	23	0	4.6	0.025	0	105	0.57	$1.18	$53.00	$114.17	$1,271
122	440	24	3	41	0	4.6	0.025	0	187	1.02	$1.18	$53.00	$114.17	$2,133
124	406	24	3	36	0	4.6	0.025	0	165	0.90	$1.18	$53.00	$114.17	$2,094
126	406	24	3	36	0	4.6	0.025	0	165	0.90	$1.18	$53.00	$114.17	$2,094
155	262	15	2	23	0.1	0.95	0.044	2.3	22	1.00	$1.18	$53.00	$114.17	$1,332
358	2286	145	15	13	0	-0.31	-0.00015	0	-4	-0.00	$1.18	$53.00	$114.17	$12,095
522	646	41	3	7	0	0.5	0.035	0	4	0.25	$1.18	$53.00	$114.17	$3,278

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 3 – Weatherstripping & Caulking

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-APR-92
FILE: ECO-3.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG #	# STORIES	A	B	WALL CONST.	# WIN.	GLASS TYPE	WIN TYPE	INFIL DESCRIP	WIN (in²/ft²)	FRAME (in²/ft²)	L (in)	W (in)	WIN PERIM (ft)	WIN AREA (ft²)	L eff (in²)	# DOORS	INFIL DESCRIP	DOOR (in²/ft²)	FRAME (in²/ft²)	L (in)	W (in)
022	1	0.016	0.004	Mason	64	Db	Cas	Low	0.011	0.019	34	47	864	710	21	2	Low	0.114	0.0143	80	60
																2	High	0.157	0.072	80	60
027																					
028																					
040	2	0.031	0.005	Mason	48	Sl	Sl	Low	0.026	0.019	73	40	904	973	44	2	Med to High	0.157	0.072	72	30
					18			Low	0.026	0.019	80	64	432	640	29	3	High	0.157	0.072	84	60
																2	Low	0.114	0.0143	84	34
041	2	0.031	0.005	Mason	43	Db	Sl	Low	0.037	0.019	32	81	810	774	43	2	Low	0.114	0.0143	80	35
																3	Med to High	0.157	0.072	80	35
056	2	0.031	0.005	Mason	120	Sl	Sl	High	0.052	0.093	80	36	2320	2400	348	4	High	0.157	0.072	84	60
058	2	0.031	0.005	Mason	120	Sl	Sl	High	0.052	0.093	80	36	2320	2400	348	4	High	0.157	0.072	84	60
060																					
061	1	0.016	0.004	Mason	10	Sl	Sl	Med to High	0.052	0.093	85	40	208	236	34	2	Fair	0.157	0.072	84	30
					5	Sl	Sl	Med to High	0.052	0.093	85	40	104	118	17	2		0.157	0.072	80	36
					3	Sl	Sl	Med to High	0.052	0.093	63	39	51	51	7	4	High	0.157	0.072	80	30
					2	Sl	Sl	Med to High	0.052	0.093	53	44	32	32	5	1	Fair to High	0.157	0.072	84	30
					2	Sl	Sl	Med to High	0.052	0.093	63	39	34	34	5		High	0.157	0.072		
					3	Sl	Sl	Med to High	0.052	0.093	63	39	51	51	7						
					3	Sl	Sl	Med to High	0.052	0.093	63	31	47	41	6						
					3	Sl	Sl	Med to High	0.052	0.093	36	36	36	27	4						
100																					
101	2	0.031	0.005	Mason	53	Sl	Sl	Med	0.052	0.093	80	34	1007	1001	145	3	Med to High	0.157	0.072	80	34
105	1	0.016	0.004	Mason	4	Db	Sl	Fair	0.074	0.093	40	28	45	31	5	3	Fair	0.157	0.072	80	34
					8	Db	Sl	Fair	0.074	0.093	48	56	139	149	25						
109	1	0.016	0.004	Mason	29	Sl	Sl	Fair	0.052	0.093	53	43	464	459	67	3	Low	0.114	0.0143	79	31
111	1	0.016	0.004	Mason	24	Sl	Sl	High	0.052	0.093	53	43	384	380	55	3	Fair	0.157	0.072	80	31
112	1	0.016	0.004	Mason	20	Sl	Sl	Fair	0.052	0.093	53	43	320	317	46	2	High	0.157	0.072	80	32
114	1	0.016	0.004	Mason	24	Sl	Sl	High	0.052	0.093	53	43	384	380	55	2	Fair	0.157	0.072	80	31
116	1	0.016	0.004	Mason	16	Sl	Sl	High	0.052	0.093	53	43	256	253	37	3	Fair	0.157	0.072	80	31
117	1	0.016	0.004	Mason	24	Sl	Sl	High	0.052	0.093	53	43	384	380	55	3	Fair	0.157	0.072	80	31
118	1	0.016	0.004	Mason	24	Sl	Sl	High	0.052	0.093	53	43	384	380	55	3	Fair	0.157	0.072	80	31
120	1	0.016	0.004	Mason	24	Sl	Sl	High	0.052	0.093	53	43	384	380	55	3	Fair	0.157	0.072	80	31
121	1	0.016	0.004	Mason	12	Sl	Sl	High	0.052	0.093	53	43	192	190	28	3	Fair	0.157	0.072	80	31
122	1	0.016	0.004	Mason	24	Sl	Sl	High	0.052	0.093	53	43	384	380	55	3	Fair	0.157	0.072	80	31
124	1	0.016	0.004	Mason	24	Sl	Sl	Fair	0.052	0.093	51	33	336	281	41	3	Fair	0.157	0.072	80	60
126	1	0.016	0.004	Mason	24	Sl	Sl	Fair	0.052	0.093	51	33	336	281	41	3	Fair	0.157	0.072	80	60
155	1	0.016	0.004	Mason	3	Sl	Sl	Med to High	0.052	0.093	40	30	35	25	4	2	Med to High	0.157	0.072	80	60
					12	Sl	Sl	Med to High	0.052	0.093	60	30	180	150	22						
358																					
522	2	0.031	0.005	Mason	32	Db	Sl	Low	0.037	0.019	60	30	480	400	22	3	Fair	0.157	0.072	80	36
					9	Db	Sl	Low	0.037	0.019	48	24	108	72	4						

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 3 – Weatherstripping & Caulking

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-APR-92
FILE: ECO-3.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG #	DOOR PERIM (FT)	DOOR AREA (ft²)	L eff (in²)	TOTAL L eff (in²)	IMPRV WIN (in²/ft²)	IMPRV FRAME (in²/ft²)	IMPRV DOOR (in²/ft²)	IMPRV FRAME (in²/ft²)	IMPRV L eff (in²)	EXIST INFIL (cfm)	IMPRV INFIL (cfm)	DELTA INFIL (cfm)	TOTAL PERIM (ft)	# WIN	# DOORS	OH DOORS PERIM (ft)
022	47	67	9	45.1	0.011	0.019	0.114	0.0143	38.4	43	36	6	957	64	4	
	47	67	15													
027										552	541	11	1059	58	8	
028										552	541	11	1059	58	8	
040	34	30	7	108.6	0.026	0.019	0.114	0.0143	95.0	126	110	16	1481	66	7	
	72	105	24													
	39	40	5													
041	38	39	5	61.7	0.011	0.019	0.114	0.0143	35.7	72	41	30	906	43	5	
	58	58	13													
056	96	140	32	380.1	0.026	0.019	0.114	0.0143	126.0	441	146	295	2416	120	4	
058	96	140	32	380.1	0.026	0.019	0.114	0.0143	126.0	441	146	295	2416	120	4	
060										4171	3835	336	2983	152	9	
061	38	35	8	122.1	0.026	0.019	0.114	0.0143	47.0	115	44	71	733	31	9	
	39	40	9													
	73	67	15													
	19	18	4													
	0	0														
100										424	419	5	422	23	4	
101	57	57	13	158.1	0.026	0.019	0.114	0.0143	52.3	184	61	123	1064	53	3	
105	57	57	13	43.1	0.037	0.019	0.114	0.0143	17.4	41	16	24	102	12	3	
109	55	51	7	73.1	0.026	0.019	0.114	0.0143	27.2	69	26	43	519	29	3	
111	56	52	12	66.9	0.026	0.019	0.114	0.0143	23.7	63	22	41	440	24	3	
112	37	36	8	54.0	0.026	0.019	0.114	0.0143	18.8	51	18	33	357	20	2	
114	37	34	8	63.0	0.026	0.019	0.114	0.0143	21.5	59	20	39	421	24	2	
116	56	52	12	48.5	0.026	0.019	0.114	0.0143	18.0	46	17	29	312	16	3	
117	56	52	12	66.9	0.026	0.019	0.114	0.0143	23.7	63	22	41	440	24	3	
118	56	52	12	66.9	0.026	0.019	0.114	0.0143	23.7	63	22	41	440	24	3	
120	56	52	12	66.9	0.026	0.019	0.114	0.0143	23.7	63	22	41	440	24	3	
121	56	52	12	39.4	0.026	0.019	0.114	0.0143	15.2	37	14	23	248	12	3	
122	56	52	12	66.9	0.026	0.019	0.114	0.0143	23.7	63	22	41	440	24	3	
124	70	100	23	63.6	0.026	0.019	0.114	0.0143	25.5	60	24	36	406	24	3	
126	70	100	23	63.6	0.026	0.019	0.114	0.0143	25.5	60	24	36	406	24	3	
155	47	67	15	40.6	0.026	0.019	0.114	0.0143	16.4	38	15	23	262	15	2	
358												13	2286	145	15	
522	58	60	14	40.2	0.037	0.019	0.114	0.0143	34.1	47	40	7	646	41	3	

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study
LOCATION Ft. McPherson & Ft Gillem

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097
X CODE A CODE B CODE C
OTHER

EFFECTIVE PRICING DATE APR 92
DRAWING NO.
ESTIMATOR RMG

DATE PREPARED 15-Apr-92
SHT OF
CHECKED BY

ECO 3 – Weatherstripping & Caulking	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
ASTRAGAL, OVERHEAD DOOR	1	LF	0.178	0.178	$18.53	$3.30			$2.50	$2.50	$5.80		
SUBTOTAL						$3.30					$5.80		
OVERHEAD, BOND	15%					$0.49					$0.87		
PROFIT	10%					$0.33					$0.58		
COST SUB-TOTAL						$4.12					$7.25		
CONTINGENCY	15%					$0.62					$1.09		
TOTAL						$4.74					$8.34		
WEATHERSTRIPPING, WINDOW	1	EA	1.110	1.110	$18.53	$20.57			$16.30	$16.30	$36.87		
SUBTOTAL						$20.57					$36.87		
OVERHEAD, BOND	15%					$3.09					$5.53		
PROFIT	10%					$2.06					$3.69		
COST SUB-TOTAL						$25.71					$46.09		
CONTINGENCY	15%					$3.86					$6.91		
TOTAL						$29.57					$53.00		
WEATHERSTRIPPING, DOOR	1	EA	2.7	2.667	$18.53	$49.42			$30.00	$30.00	$79.42		
SUBTOTAL						$49.42					$79.42		
OVERHEAD, BOND	15%					$7.41					$11.91		
PROFIT	10%					$4.94					$7.94		
COST SUB-TOTAL						$61.77					$99.27		
CONTINGENCY	15%					$9.27					$14.89		
TOTAL						$71.04					$114.17		
CAULKING, SILICONE	1	LF	0.031	0.031	$19	$0.57			$0.25	$0.25	$0.82		
SUBTOTAL						$0.57					$0.82		
OVERHEAD, BOND	15%					$0.09					$0.12		
PROFIT	10%					$0.06					$0.08		
COST SUB-TOTAL						$0.72					$1.02		
CONTINGENCY	15%					$0.11					$0.15		
TOTAL						$0.83					$1.18		

DA FORM 5416-R, APR 85

E M C ENGINEERS, INC.
Denver • Colorado Springs • Atlanta • Germany

JOB #3105.000 FT. MCPHERSON/GILLEM
SHEET NO. ____ OF ____
CALCULATED BY CEL DATE 7/20/92
CHECKED BY ____ DATE ____
SCALE NONE

Weatherstripping cost estimates taken from MEANS BUILDING CONSTRUCTION COST DATA 1992

Overhead doors:
- Interlocking aluminum, 5/8" x 1" neoprene bulb insert.

Windows:
- Bronze weatherstripping for 3′ x 5′ double hung window.

Personnel doors:
- Metal frame, bronze weatherstripping, spring type.

APPENDIX C-4

MEASURE HOT WATER TEMPERATURES

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 4 – Domestic Hot Water Temperatures

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-APR-92
FILE: ECO-4.WK3
PREPARED BY: CHRIS STANLEY
CHECKED BY:

BLDG #	BLDG DESCRIPTION	LOCATION IN BLDG.	HOT WTR TEMP (°F)
22	ADMINISTRATION	Rm. 107	130
		Rm. 104	134
27	GUEST	Apt 1, Kitchen	130
		Apt 1, Bathroom	129
		Apt 2, Kitchen	128
		Apt 2, Bathroom	127
28	GUEST	Apt 1, Kitchen	148
		Apt 1, Bathroom	149
40	UPH	Flr 1, Kitchen	131
		Basement, Bathroom	129
41	ADMINISTRATION	Flr 1, Bathroom	154
		Flr 2, Bathroom	148
42	CHAPEL	Kitchen	140
		Men's Bathroom	142
56	UPH	Flr 1, Bathroom	136
58	UPH	Flr 1, Bathroom	136
60	UPH	Flr 1, Bathroom	150
		Flr 1, Bathroom	145
		Flr 2, Bathroom	120
		Flr 2, Bathroom	101
61	LAB	Bathroom	144
		Sink	144
62	UPH	Flr 1, Bathroom	127
100	DENTAL	Men's Bathroom	100
101	DENTAL	Men's Bathroom	124
		Dental Area, Men's Bathroom	128
102	POLICE	Bathroom	119
105	LAB	Common Bathroom	137
		Exam Room	137
109	GUEST (T)	Rm. 1, Sink	131
		Kitchen	129
111	ADMINISTRATION	Men's Bathroom	114
		Women's Bathroom	114
112	ADMINISTRATION	Men's Bathroom	134
		Women's Bathroom	136
114	ADMINISTRATION	Men's Bathroom	101
116	ADMINISTRATION	Men's Bathroom	113
117	CLASSROOM	No Water	N/A
118	ADMINISTRATION	No Water	N/A
120	ADMINISTRATION	No Water	N/A
121	ADMINISTRATION	No Water	N/A
122	ADMINISTRATION	Common Bathroom	113
124	ADMINISTRATION	Common Bathroom	121
126	ADMINISTRATION	Common Bathroom	121
131	CLINIC	Flr 2, Common Bathroom	124

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 4 – Domestic Hot Water Temperatures

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-APR-92
FILE: ECO-4.WK3
PREPARED BY: CHRIS STANLEY
CHECKED BY:

BLDG #	BLDG DESCRIPTION	LOCATION IN BLDG.	HOT WTR TEMP (°F)
		Flr 1, Men's Bathroom	124
155	NCO CLUB	N.E. Bathroom	180
		Downstairs Bar	170
168	ADMINISTRATION	Rm. 209	127
		Rm. 103	125
170	HOSPITAL		121
171	HOSPITAL	Men's Bathroom, Basement	104
178	TRAINING	Flr 1, Men's Bathroom	126
179	CLASSROOM	Flr 1, Men's Bathroom	149
181	ADMINISTRATION	Flr 1, Men's Bathroom	168
184	STORAGE	Men's Bathroom, Flr 1, E	122
		Men's Bathroom, Flr 2, W	134
187	PX MAINTENAN	Bathroom, NE	133
200	ADMINISTRATION	Men's Room, Basement, W	110
		Men's Room, Basement, N	135
		Janitor's Closet, 1st Fl, N	140
		Men's Room, 2nd Fl, W	113
		2nd Fl, N	102
		Rm. 313, 3rd Fl, N	104
		Rm 321, 3rd Fl, W	108
206	ADMINISTRATION	Men's Bathroom, SW	132
246	ADMINISTRATION	Men's Bathroom, NW	135
250	LIBRARY	Tech Services Office	84
358	ADMINISTRATION	Men's Bathroom, NW	134
		Men's Bathroom, SE	139
360	LAB	Loading Dock, Sink	126
		Meat Dept, Sink	124
363	MAINTENANCE	Rm 17D2, Bathroom	101
		Rm 14F1, Janitor's Closet	122
		Rm 11F1, Janitor's Closet	125
		Rm 8F2, Bathroom	128
		Rm 1C2, Bathroom	111
		Rm 24G1, Bathroom	134
366	STORAGE	Men's Bathroom	108
400	MORAL SUPPORT	Kitchen	109
		Men's Bathroom	109
401	BOWLING	Men's Bathroom, Rm 121	121
		Kitchen	137
500	DINING FACILITY	Bathroom, Downstairs, S	146
		Upstairs, N End	134
514	DAY CARE	Bathroom, Near Office B	97
		Kitchen, Near Rm 4, Sink	150
522	GUEST	Kitchen, Sink	125

APPENDIX C-5

ELECTRIC MOTORS

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: MECO25
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-5 HIGH EFFICIENCY MOTOR
ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	146176.
B. SIOH	$	8040.
C. DESIGN COST	$	8771.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	162987.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	902.	$ 6739.	15.61	105199.
B. DIST	$ .00	0.	$ 0.	21.66	0.
C. RESID	$ .00	0.	$ 0.	26.51	0.
D. NAT G	$ 4.67	0.	$ 0.	23.77	0.
E. COAL	$ .00	0.	$ 0.	16.06	0.
F. TOTAL		902.	$ 6739.		$ 105199.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 5594.
(1) DISCOUNT FACTOR (TABLE A) 14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 81281.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 81281.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 34716.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) .86
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 12333.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 186480.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.14
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 13.22

HIGH-EFFICIENCY MOTOR REPLACEMENT SAMPLE CALCULATION, ECO #5
BUILDING 40

Given:

Motor Horsepower	= 3 hp	-from field survey
Operation Hours	= 8,760 hrs / yr	-from field survey
Standard Motor Efficiency	= 84%	-from standard motor info
High Eff Motor Efficiency	= 88.5%	-from high efficiency motor info
Motor Load Factor	= 85%	-assumed
Gas Cost	= $4.67 / MBtu	-from utility rate analysis
Electric Cost	= $0.0255 / kWh	-from utility rate analysis
Demand Cost	= $8.85 / kW	-from utility rate analysis

Existing Demand:

$$\frac{(3\ \text{hp}) * (0.746\ \text{kw/ hp}) * (85\%)}{(84\%)} = 2.26\ \text{kw}$$

Improved Demand:

$$\frac{(3\ \text{hp}) * (0.746\ \text{kw / hp}) * (85\%)}{(88.5\%)} = 2.15\ \text{kw}$$

Peak Demand Savings:

2.26 kW - 2.15 kW = 0.11 kW

Annual Electric Savings:

(0.11 kW)*(8,760 hrs / yr) = 964 kWh / yr

Annual Cost Savings:

(0.0 MBtu)*($4.67 / MBtu) + (964 kWh)*($0.0255 / kWh) + (0.11 kW)*($8.85 / kW)*(4 + 0.95 * 8) = $36 / yr

Estimated Construction Cost:

$624 / 3 hp motor -from engineer's cost estimate

$624 + ($624 * .055 SIOH) + ($624 * .06 DESIGN) = $695

INSTALL HIGH EFFICIENCY MOTORS
ECO #5, Ft. McPherson

Variable Speed Drive Load Factor

Percentage breakdown of Cooling Airflow
- from Computer Simulation

Load %	Hours %	Power Input Ratio Fm. T.2 p.2
70	56	0.43
80	13	0.62
90	7	0.85
100	24	1.16

$$\text{Load Factor} = \frac{(56)(0.43) + (13)(0.62) + (7)(0.85) + (24)(1.16)}{100}$$

Load Factor = **66%**

Profit Improvement With Variable Frequency Drives

SCOTT A. MOSES*
WAYNE C. TURNER, *Ph.D., P.E., CEM*
JORGE B. WONG
MARK R. DUFFER
Oklahoma State University
Stillwater, OK

Table 1. Values for Calculating Annual Savings

Load Ratio 1	Power Input Ratio (Old) 2	Power Input Ratio (VFD) 3	Duty Cycle Fraction 4	KWh Saved 5	Dollar Savings 6
0.20	__.__	0.09	0.00	____	____
0.30	__.__	0.11	0.05	____	____
0.40	__.__	0.14	0.16	____	____
0.50	__.__	0.20	0.23	____	____
0.60	__.__	0.29	0.23	____	____
0.70	__.__	0.43	0.20	____	____
0.80	__.__	0.62	0.09	____	____
0.90	__.__	0.85	0.03	____	____
1.00	__.__	1.16	0.01	____	____

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 16-Jul-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	23.77 UPWG
Electric Savings	$0.0255 / kWh	15.61 UPWE
Demand Savings	$8.85 / kW	14.53 UPW

Economic Life: 25 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON-ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
514	0	3,004	0	10	$77	$35	$0	$112	$782	2.2	7.0
206	1	8,329	0	28	$212	$98	$0	$310	$2,207	2.1	7.1
360	0	3,294	0	11	$84	$39	$0	$123	$1,103	1.7	9.0
200	37	167,856	0	572	$4,280	$3,839	$0	$8,119	$107,960	1.1	13.3
056	1	8,276	0	28	$211	$97	$0	$308	$4,126	1.1	13.4
058	1	8,276	0	28	$211	$97	$0	$308	$4,126	1.1	13.4
060	1	8,276	0	28	$211	$97	$0	$308	$4,126	1.1	13.4
062	1	8,276	0	28	$211	$97	$0	$308	$4,126	1.1	13.4
246	1	4,700	0	16	$120	$64	$0	$183	$2,544	1.1	13.9
363	7	23,735	0	81	$605	$763	$0	$1,368	$18,911	1.1	13.8
181	1	7,786	0	27	$199	$122	$0	$320	$4,478	1.1	14.0
400	0	2,377	0	8	$61	$28	$0	$88	$1,269	1.1	14.3
168	0	1,452	0	5	$37	$17	$0	$54	$782	1.1	14.5
401	0	1,452	0	5	$37	$17	$0	$54	$782	1.1	14.5
131	0	726	0	2	$19	$34	$0	$53	$782	1.0	14.9
170	1	4,785	0	16	$122	$112	$0	$234	$3,524	1.0	15.0
101	0	1,919	0	7	$49	$39	$0	$88	$1,359	1.0	15.5
TOTAL	54	264,518	0	902	$6,745	$5,594	$0	$12,339	$162,966	1.1	13.2
171	1	4,167	0	14	$106	$132	$0	$238	$3,868	0.9	16.3
500	1	11,607	0	40	$296	$153	$0	$449	$7,782	0.9	17.3
184	1	10,820	0	37	$276	$127	$0	$403	$7,160	0.9	17.8
100	0	1,044	0	4	$27	$12	$0	$39	$684	0.9	17.6
040	0	1,009	0	3	$26	$12	$0	$38	$695	0.8	18.5
041	0	1,585	0	5	$40	$19	$0	$59	$1,153	0.8	19.6
042	0	1,534	0	5	$39	$24	$0	$63	$1,330	0.7	21.0
022	0	610	0	2	$16	$14	$0	$30	$684	0.7	22.9
155	0	1,051	0	4	$27	$25	$0	$51	$1,261	0.6	24.5
522	0	1,044	0	4	$27	$24	$0	$51	$1,368	0.6	26.8
061	0	1,026	0	3	$26	$24	$0	$50	$1,379	0.5	27.5
358	1	3,000	0	10	$77	$70	$0	$147	$4,118	0.5	28.0

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE:
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	NOTE	OVER / UNDER SIZED	NAMEPLATE HP	NAMEPLATE FLA	NAMEPLATE VOLTS	NAMEPLATE EFF	MEASURED AMPS	MEASURED PF	MEASURED VOLTS	LOAD FACTOR (%)	EXIST EFF	IMPRVD EFF	DEMAND SAVINGS (kW)	HRS/ YEAR	ELECTRIC SAVINGS (kWh/yr)
022	CWP			2.0	5.7	208	0.79				85%	79.0%	86.5%	0.14	4380	610
	TOTAL			2.0										0.1		610
040	DTW PUMP			3.0	9.2	230					85%	84.0%	88.5%	0.12	8760	1,009
	TOTAL			3.0										0.1		1,009
041	AHU 2			1.0	3.5	200					85%	77.0%	86.5%	0.09	8760	792
	AHU 3			1.0	3.5	200					85%	77.0%	86.5%	0.09	8760	792
	TOTAL			2.0										0.2		1,585
042	AHU 1			3.0	8.3	230					85%	84.0%	88.5%	0.12	8760	1,009
	HWP			1.5	5.3	208	0.78				85%	78.0%	86.5%	0.12	4380	525
	TOTAL			4.5										0.2		1,534
056,05	DTWP 1			5.0	5.4	230					85%	85.5%	89.5%	0.17	8760	1,452
060,062	DTWP 2			10.0	29	208					85%	87.5%	91.7%	0.33	8760	2,908
	DTWP 3			10.0	29	230					85%	87.5%	91.7%	0.33	8760	2,908
	DTWP 4			3.0	9	230					85%	84.0%	88.5%	0.12	8760	1,009
	TOTAL			28.0										0.9		8,276
061	HWP 1			2.0	6.8	200					85%	80.0%	86.5%	0.12	4380	522
	HWP 2			3.0	9.2	200					85%	84.0%	88.5%	0.12	4380	504
	TOTAL			5.0										0.2		1,026
100	AHU 1			2.0	7.1	200					85%	80.0%	86.5%	0.12	8760	1,044
	TOTAL			2.0										0.1		1,044
101	DTW			5.0	14.8	208					85%	85.5%	89.5%	0.17	8760	1,452
	SUMP PUMP			1.0	12.4	1115	0.67				85%	67.0%	86.5%	0.21	2190	467
	TOTAL			6.0										0.4		1,919
131	HWP 1			5.0	13.8	208	0.855				85%	85.5%	89.5%	0.17	4380	726
	HWP 2	Off		5.0	13.8	208	0.855				85%	85.5%	89.5%	0.17		
	TOTAL			10.0										0.3		726
155	AHU 1			1.0	3.8	200					85%	77.0%	86.5%	0.09	4380	396
	AHU 2			2.0	6.8	208	0.785				85%	78.5%	86.5%	0.15	4380	654
	TOTAL			3.0										0.2		1,051
168	DTWP			5.0	16	200					85%	85.5%	89.5%	0.17	8760	1,452
	TOTAL			5.0										0.2		1,452
170	CHWP			15	42	208	0.885				85%	88.5%	92.4%	0.45	4380	1,987
	HW PUMP			15	38	230	0.87	38	0.83	208	85%	87.0%	92.4%	0.64	4380	2,799
	TOTAL			30.0										1.1		4,785

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE:
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	NOTE	OVER / UNDER SIZED	NAMEPLATE HP	NAMEPLATE FLA	NAMEPLATE VOLTS	NAMEPLATE EFF	MEASURED AMPS	MEASURED PF	MEASURED VOLTS	LOAD FACTOR (%)	EXIST EFF	IMPRVD EFF	DEMAND SAVINGS (kW)	HRS/ YEAR	ELECTRIC SAVINGS (kWh/yr)
171	AHU 1	Off		5.0	16.2	200					85%	85.5%	89.5%	0.17	0	
	AHU 2	Off		5.0	16	200					85%	85.5%	89.5%	0.17	0	
	AHU 3			5.0	16	200					85%	85.5%	89.5%	0.17	4380	726
	HW PUMP			15.0	4.7	200					85%	88.5%	92.4%	0.45	4380	1,987
	CWP			10	31.2	200					85%	87.5%	91.7%	0.33	4380	1,454
	TOTAL			40.0										1.3		4,167
181	AHU 1		OVER	10.0	27.0	230	0.86	21.0	0.79	204	85%	86.0%	91.7%	0.46	8760	4,015
	AHU 2			1.5	5.9	200					85%	77.0%	86.5%	0.14	8760	1,188
	CWP 1			5	13.2	230					85%	85.5%	89.5%	0.17	4380	726
	CWP 2			7.5	18.8	230					85%	86.5%	91.7%	0.31	4380	1,366
	HWP			1.5	1.2	208	0.785				85%	78.5%	86.5%	0.11	4380	491
	TOTAL			25.5										1.2		7,786
184	AHU 1			1.0	4.2	200					85%	77.0%	86.5%	0.09	8760	792
	AHU 2			1.0	3.6	208					85%	77.0%	86.5%	0.09	8760	792
	AHU 3			2	6.2	208	0.815				85%	81.5%	86.5%	0.09	8760	788
	AHU 4			2	6.6	200					85%	80.0%	86.5%	0.12	8760	1,044
	AHU 5			2	6.8	208					85%	80.0%	86.5%	0.12	8760	1,044
	AHU 6			1.5	5.5	200	0.785				85%	78.5%	86.5%	0.11	8760	982
	AHU 7			1.5	5.5	200	0.785				85%	78.5%	86.5%	0.11	8760	982
	AHU 8			1.5	5.5	200	0.785				85%	78.5%	86.5%	0.11	8760	982
	AHU 9			1.5	5.5	200	0.785				85%	78.5%	86.5%	0.11	8760	982
	AHU 10			1.5	5.5	200	0.785				85%	78.5%	86.5%	0.11	8760	982
	DTP			5	15.8	200					85%	85.5%	89.5%	0.17	8760	1,452
	TOTAL			20.5										1.2		10,820

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 01-Sep-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	NOTE	OVER / UNDER SIZED	NAMEPLATE HP	NAMEPLATE FLA	NAMEPLATE VOLTS	NAMEPLATE EFF	MEASURED AMPS	MEASURED PF	MEASURED VOLTS	LOAD FACTOR (%)	EXIST EFF	IMPRVD EFF	DEMAND SAVINGS (kW)	HRS/ YEAR	ELECTRIC SAVINGS (kWh/yr)
200	AHU 1, SUPPLY	VS		30.0	25	460		17.8	0.59	472	66%	90.2%	93.6%	0.59	5658	3,366
	AHU 1, RETURN	VS		10	–	460		7.4	0.5	469	66%	87.5%	91.7%	0.26	5658	1,458
	AHU 2, SUPPLY	VS		25	64	460	0.875	14.4	0.69	225	66%	87.5%	93.0%	0.83	5658	4,707
	AHU 2, RETURN	VS		10	12	460	0.855	14	0.83	470	66%	85.5%	91.7%	0.39	5658	2,203
	AHU 3, SUPPLY	VS		30	30	460		16	0.48	468	66%	90.2%	93.6%	0.59	5658	3,366
	AHU 3, RETURN	VS		15	15	460		8.8	0.52	468	66%	88.5%	92.4%	0.35	5658	1,993
	AHU 4, SUPPLY	VS		30	30	460		17	0.46	460	66%	90.2%	93.6%	0.59	5658	3,366
	AHU 4, RETURN	VS		10	10	460		12	0.57	468	66%	87.5%	91.7%	0.26	5658	1,458
	AHU 5, SUPPLY	VS		40	30	460		22.6	0.52	471	66%	91.0%	94.1%	0.71	5658	4,034
	AHU 5, RETURN	VS		15	15	460		10	0.5	466	66%	88.5%	92.4%	0.35	5658	1,993
	AHU 6, SUPPLY	VS		40	40	460		19.8	0.99	469	66%	91.0%	94.1%	0.71	5658	4,034
	AHU 6, RETURN	VS		15	230	460		11.5	0.64	468	66%	88.5%	92.4%	0.35	5658	1,993
	AHU 7, SUPPLY	VS		30	30	460		18.4	0.51	473	66%	90.2%	93.6%	0.59	8760	5,211
	AHU 7, RETURN	VS		10	–	460		7.5	0.48	473	66%	87.5%	91.7%	0.26	8760	2,258
	AHU 8, SUPPLY	VS		40	40	460		11	0.97	472	66%	91.0%	94.1%	0.71	5658	4,034
	AHU 8, RETURN	VS		10	10	460		10.7	0.52	472	66%	87.5%	91.7%	0.26	5658	1,458
	AHU 9, SUPPLY	VS		30	25	460		21	0.6	473	66%	90.2%	93.6%	0.59	5658	3,366
	AHU 9, RETURN	VS		10	10	460		9.5	0.57	472	66%	87.5%	91.7%	0.26	5658	1,458
	AHU 10, SUPPLY	VS		40	30	460		26	0.97	473	66%	91.0%	94.1%	0.71	5658	4,034
	AHU 10, RETURN	VS		15	15	460		9.2	0.46	474	66%	88.5%	92.4%	0.35	5658	1,993
	AHU 11, SUPPLY	VS		30	30	460		22.2	0.61	473	66%	90.2%	93.6%	0.59	5658	3,366
	AHU 11, RETURN	VS		15	15	460		8	0.5	473	66%	88.5%	92.4%	0.35	5658	1,993
	AHU 12, SUPPLY	VS		40	40	460		25.8	0.99	472	66%	91.0%	94.1%	0.71	5658	4,034
	AHU 12, RETURN	VS		15	15	460		12.6	0.65	472	66%	88.5%	92.4%	0.35	5658	1,993
	AHU 13, SUPPLY			5	7.6	460					85%	85.5%	89.5%	0.17	8760	1,452
	AHU 13, RETURN			1	1.8	460					85%	77.0%	86.5%	0.09	8760	792
	AHU 14, SUPPLY	VS		60	50	460		12.6	0.98	467	66%	93.0%	94.5%	0.50	8760	4,417
	AHU 14, RETURN	VS		25	25	460		30.3	0.67	467	66%	90.2%	93.0%	0.41	8760	3,599
	AHU 16, SUPPLY			5	7.6	460					85%	85.5%	89.5%	0.17	8760	1,452
	AHU 16, RETURN			1	1.8	460					85%	77.0%	86.5%	0.09	8760	792
	AHU 17, SUPPLY			3	4.8	460		2.6	0.41	470	85%	84.0%	88.5%	0.12	8760	1,009
	COND PUMP#1	Off		75	87	460	0.887				85%	88.7%	94.5%	3.29		
	COND PUMP#2	Off		75	87	460	0.887				85%	88.7%	94.5%	3.29		
	COND PUMP#3			75	87	460	0.887	77.3	0.85	472	85%	88.7%	94.5%	3.29	8760	28,827
	CONST PRESS			25	34	460					85%	90.2%	93.0%	0.53	8760	4,635

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 01-Sep-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	NOTE	OVER / UNDER SIZED	NAMEPLATE HP	NAMEPLATE FLA	NAMEPLATE VOLTS	NAMEPLATE EFF	MEASURED AMPS	MEASURED PF	MEASURED VOLTS	LOAD FACTOR (%)	EXIST EFF	IMPRVD EFF	DEMAND SAVINGS (kW)	HRS/ YEAR	ELECTRIC SAVINGS (kWh/yr)
200	CHWP#1	Off		30	37	460	0.883				85%	88.3%	93.6%	1.22		
CONT.	CHWP#2	Off		30	37	460	0.883				85%	88.3%	93.6%	1.22		
	CHWP#3			30	37	460	0.883	27.3	0.83	472	85%	88.3%	93.6%	1.22	8760	10,686
	CHWP#4	Off, VS		60	70	460					66%	93.0%	94.5%	0.50		
	CHWP#4A	VS		60	70	460		25.5	0.64	32	66%	93.0%	94.5%	0.50	8760	4,417
	CHWP#5	Off, VS		50	60	460					66%	91.7%	94.1%	0.68		
	CHWP#6	VS		50	60	460	0.903	46	0.64	456	66%	90.3%	94.1%	1.10	8760	9,644
	C TOWER#1			50	65	460		36	0.82	472	85%	91.7%	94.1%	0.88	8760	7,725
	C TOWER#2			50	65	460					85%	91.7%	94.1%	0.88	4380	3,862
	C TOWER#3	Off		50	65	460					85%	91.7%	94.1%	0.88		
	AIR COMP#1			20	27	460	0.875	22	0.77	472	85%	87.5%	93.0%	0.86	4380	3,754
	AIR COMP#2			20	26.5	460	0.875				85%	87.5%	93.0%	0.86		
	HWP#1	Off		3	4.3	460					85%	84.0%	88.5%	0.12		
	HWP#2			3	4.3	460					85%	84.0%	88.5%	0.12	8760	1,009
	HWP#3	Off		1.5	2.6	460					85%	77.0%	86.5%	0.14		
	HWP#4			5	6.5	460					85%	85.5%	89.5%	0.17	8760	1,452
	HWP#5			5	6.5	460					85%	85.5%	89.5%	0.17	8760	1,452
	HWP#6	Off		3	4.5	460					85%	84.0%	88.5%	0.12		
	HWP#7			3	4.5	460					85%	84.0%	88.5%	0.12	8760	1,009
	HWP#8	Off		3	4.3	460					85%	84.0%	88.5%	0.12		
	HWP#9			7.5	9.3	460					85%	86.5%	91.7%	0.31	8760	2,731
	HWP#10	Off		5	6.5	460					85%	85.5%	89.5%	0.17		
	DCW PUMP#1			15	19	460					85%	88.5%	92.4%	0.45	8760	3,974
	DCW PUMP#2	Off		15	19	460					85%	88.5%	92.4%	0.45		
	DCW PUMP#3	Off		15	19	460					85%	88.5%	92.4%	0.45		
	TOTAL			1,489										37.4		167,856
206	DTWP#1			7.5	24	208	0.84				85%	84.0%	91.7%	0.48	8760	4,165
	DTWP#2			7.5	24	208	0.84				85%	84.0%	91.7%	0.48	8760	4,165
	TOTAL			15.0										1.0		8,329
246	CW PUMP			5	15.6	200					85%	85.5%	89.5%	0.17	4380	726
	AHU		OVER	15	43	208		31	0.66	206	85%	88.5%	92.4%	0.45	8760	3,974
	TOTAL			20.0										0.6		4,700

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE:
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	NOTE	OVER / UNDER SIZED	NAMEPLATE HP	NAMEPLATE FLA	NAMEPLATE VOLTS	NAMEPLATE EFF	MEASURED AMPS	MEASURED PF	MEASURED VOLTS	LOAD FACTOR (%)	EXIST EFF	IMPRVD EFF	DEMAND SAVINGS (kW)	HRS/ YEAR	ELECTRIC SAVINGS (kWh/yr)
358	AHU 1			5.0	16.6	200					85%	85.5%	89.5%	0.17	4380	726
	AHU 3			1	3.8	230					85%	77.0%	86.5%	0.09	4380	396
	AHU 4			2	6.5	208					85%	80.0%	86.5%	0.12	4380	522
	AHU 6			3	9.2	230					85%	84.0%	88.5%	0.12	4380	504
	HW PUMP			2	7.8	200					85%	80.0%	86.5%	0.12	4380	522
	CW PUMP			3	21	200	0.855				85%	85.5%	88.5%	0.08	4380	330
	TOTAL			16.0										0.7		3,000
360	AHU			7.5	23	208	0.855				85%	85.5%	91.7%	0.38	8760	3,294
	TOTAL			7.5										0.4		3,294
363	AHU 1			10.0	12.5	460	0.856	12.0	0.88	477	85%	85.6%	91.7%	0.49	4015	1,978
	AHU 2			7.5	10.8	460					85%	86.5%	91.7%	0.31	4015	1,252
	AHU 3			5			0.81				85%	81.0%	89.5%	0.37	4015	1,493
	AHU 4			5	6.6	460	0.855				85%	85.5%	89.5%	0.17	4015	665
	AHU 5			3	4.5	460	0.815				85%	81.5%	88.5%	0.18	4015	741
	AHU 5A			3	4.3	460	0.82				85%	82.0%	88.5%	0.17	4015	684
	AHU 6			5	6.6	460	0.855				85%	85.5%	89.5%	0.17	4015	665
	AHU 7			7.5	10.8	460	0.84				85%	84.0%	91.7%	0.48	4015	1,909
	AHU 8			7.5	10.8	460	0.84				85%	84.0%	91.7%	0.48	4015	1,909
	AHU 9		OVER	15	19.5	460	0.885	9.9	0.45	465	85%	88.5%	92.4%	0.45	4015	1,821
	AHU 10		OVER	20	59	200	0.875	30	0.52	200	85%	87.5%	93.0%	0.86	4015	3,441
	AHU 11	No Acce														
	AHU 12			3	10.4	200	0.815				85%	81.5%	88.5%	0.18	4015	741
	AHU 13	No Acce														
	CHWP#1		OVER	15	18.3	460	0.885	12.8	0.92	482	85%	88.5%	92.4%	0.45	4380	1,987
	CHWP#2	Off		10	14	460	0.85				85%	85.0%	91.7%	0.55		
	HWP#1		OVER	10	12.2	460	0.885	7.5	0.85	477	85%	88.5%	91.7%	0.25	4380	1,095
	COOLING TOWER			7.5	11	460					85%	86.5%	91.7%	0.31	4380	1,366
	COND PUMP#1		OVER	15	19.5	460	0.885	9.9	0.79	475	85%	88.5%	92.4%	0.45	4380	1,987
	COND PUMP#2	Off		20	25	460	0.86				85%	86.0%	93.0%	1.11		
	TOTAL			169.0										7.4		23,735
400	AHU 1			1.5	5.0	200					85%	77.0%	86.5%	0.14	8760	1,188
	AHU 2			1.5	5	200					85%	77.0%	86.5%	0.14	8760	1,188
	TOTAL			3.0										0.3		2,377
401	AHU			5.0	14.6	208					85%	85.5%	89.5%	0.17	8760	1,452
	TOTAL			5.0										0.2		1,452

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE:
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	NOTE	OVER / UNDER SIZED	NAMEPLATE HP	NAMEPLATE FLA	NAMEPLATE VOLTS	NAMEPLATE EFF	MEASURED AMPS	MEASURED PF	MEASURED VOLTS	LOAD FACTOR (%)	EXIST EFF	IMPRVD EFF	DEMAND SAVINGS (kW)	HRS/ YEAR	ELECTRIC SAVINGS (kWh/yr)
500	AHU 1			3	10.7	208	0.815				85%	81.5%	88.5%	0.18	8760	1,617
	AHU 2			5	15	200	0.865				85%	86.5%	89.5%	0.12	8760	1,076
	AHU 3			5	15	200	0.865				85%	86.5%	89.5%	0.12	8760	1,076
	AHU 4			2	6.8	208	0.785				85%	78.5%	86.5%	0.15	8760	1,309
	AHU 5			2	5.5	208					85%	80.0%	86.5%	0.12	8760	1,044
	AHU 6			1		208					85%	77.0%	86.5%	0.09	8760	792
	AHU 7			1.5	5.5	208					85%	77.0%	86.5%	0.14	8760	1,188
	AHU 8			2	6.7	200					85%	80.0%	86.5%	0.12	8760	1,044
	EF 5			3	7.8	208					85%	84.0%	88.5%	0.12	8760	1,009
	CHW PUMP			5		208					85%	85.5%	89.5%	0.17	4380	726
	HW PUMP			5	5.5	208					85%	85.5%	89.5%	0.17	4380	726
	TOTAL			34.5										1.5		11,607
514	AHU 3			5.0	16.0	208	0.816				85%	81.6%	89.5%	0.34	8760	3,004
	TOTAL			5.0										0.3		3,004
522	CHWP			2.0	8.1	200					85%	80.0%	86.5%	0.12	4380	522
	HWP			2	4.2	200					85%	80.0%	86.5%	0.12	4380	522
	TOTAL			4.0										0.2		1,044

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE:
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	COST MOTOR ($)	COST LABOR ($)	SUB TOTAL ($)	OH&B 15%	PROFIT 10%	SUB TOTAL ($)	CONT 15%	TOTAL ($)
022	CWP	$359	$68	$427	$64	$43	$534	$80	$614
	TOTAL								$614
040	DTW PUMP	$366	$68	$434	$65	$43	$542	$81	$624
	TOTAL								$624
041	AHU 2	$292	$68	$360	$54	$36	$450	$67	$517
	AHU 3	$292	$68	$360	$54	$36	$450	$67	$517
	TOTAL								$1,035
042	AHU 1	$366	$68	$434	$65	$43	$542	$81	$624
	HWP	$328	$68	$396	$59	$40	$495	$74	$569
	TOTAL								$1,193
056,058	DTWP 1	$420	$68	$488	$73	$49	$610	$91	$701
060,062	DTWP 2	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	DTWP 3	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	DTWP 4	$366	$68	$434	$65	$43	$542	$81	$624
	TOTAL								$3,700
061	HWP 1	$359	$68	$427	$64	$43	$534	$80	$614
	HWP 2	$366	$68	$434	$65	$43	$542	$81	$624
	TOTAL								$1,237
100	AHU 1	$359	$68	$427	$64	$43	$534	$80	$614
	TOTAL								$614
101	DTW	$420	$68	$488	$73	$49	$610	$91	$701
	SUMP PUMP	$292	$68	$360	$54	$36	$450	$67	$517
	TOTAL								$1,219
131	HWP 1	$420	$68	$488	$73	$49	$610	$91	$701
	HWP 2								
	TOTAL								$701
155	AHU 1	$292	$68	$360	$54	$36	$450	$67	$517
	AHU 2	$359	$68	$427	$64	$43	$534	$80	$614
	TOTAL								$1,131
168	DTWP	$420	$68	$488	$73	$49	$610	$91	$701
	TOTAL								$701
170	CHWP	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	HW PUMP	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	TOTAL								$3,161

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE:
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	COST MOTOR ($)	COST LABOR ($)	SUB TOTAL ($)	OH&B 15%	PROFIT 10%	SUB TOTAL ($)	CONT 15%	TOTAL ($)
171	AHU 1								
	AHU 2								
	AHU 3	$420	$68	$488	$73	$49	$610	$91	$701
	HW PUMP	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	CWP	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	TOTAL								$3,469
181	AHU 1	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	AHU 2	$328	$68	$396	$59	$40	$495	$74	$569
	CWP 1	$420	$68	$488	$73	$49	$610	$91	$701
	CWP 2	$616	$72	$688	$103	$69	$861	$129	$990
	HWP	$328	$68	$396	$59	$40	$495	$74	$569
	TOTAL								$4,017
184	AHU 1	$292	$68	$360	$54	$36	$450	$67	$517
	AHU 2	$292	$68	$360	$54	$36	$450	$67	$517
	AHU 3	$359	$68	$427	$64	$43	$534	$80	$614
	AHU 4	$359	$68	$427	$64	$43	$534	$80	$614
	AHU 5	$359	$68	$427	$64	$43	$534	$80	$614
	AHU 6	$328	$68	$396	$59	$40	$495	$74	$569
	AHU 7	$328	$68	$396	$59	$40	$495	$74	$569
	AHU 8	$328	$68	$396	$59	$40	$495	$74	$569
	AHU 9	$328	$68	$396	$59	$40	$495	$74	$569
	AHU 10	$328	$68	$396	$59	$40	$495	$74	$569
	DTP	$420	$68	$488	$73	$49	$610	$91	$701
	TOTAL								$6,421

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 17-Jul-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	COST MOTOR ($)	COST LABOR ($)	SUB TOTAL ($)	OH&B 15%	PROFIT 10%	SUB TOTAL ($)	CONT 15%	TOTAL ($)
200	AHU 1, SUPPLY	$1,639	$152	$1,791	$269	$179	$2,239	$336	$2,575
	AHU 1, RETURN	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	AHU 2, SUPPLY	$1,396	$146	$1,542	$231	$154	$1,928	$289	$2,217
	AHU 2, RETURN	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	AHU 3, SUPPLY	$1,639	$152	$1,791	$269	$179	$2,239	$336	$2,575
	AHU 3, RETURN	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	AHU 4, SUPPLY	$1,639	$152	$1,791	$269	$179	$2,239	$336	$2,575
	AHU 4, RETURN	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	AHU 5, SUPPLY	$2,212	$183	$2,395	$359	$239	$2,994	$449	$3,443
	AHU 5, RETURN	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	AHU 6, SUPPLY	$2,212	$183	$2,395	$359	$239	$2,994	$449	$3,443
	AHU 6, RETURN	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	AHU 7, SUPPLY	$1,639	$152	$1,791	$269	$179	$2,239	$336	$2,575
	AHU 7, RETURN	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	AHU 8, SUPPLY	$2,212	$183	$2,395	$359	$239	$2,994	$449	$3,443
	AHU 8, RETURN	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	AHU 9, SUPPLY	$1,639	$152	$1,791	$269	$179	$2,239	$336	$2,575
	AHU 9, RETURN	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	AHU 10, SUPPLY	$2,212	$183	$2,395	$359	$239	$2,994	$449	$3,443
	AHU 10, RETURN	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	AHU 11, SUPPLY	$1,639	$152	$1,791	$269	$179	$2,239	$336	$2,575
	AHU 11, RETURN	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	AHU 12, SUPPLY	$2,212	$183	$2,395	$359	$239	$2,994	$449	$3,443
	AHU 12, RETURN	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	AHU 13, SUPPLY	$420	$68	$488	$73	$49	$610	$91	$701
	AHU 13, RETURN	$292	$68	$360	$54	$36	$450	$67	$517
	AHU 14, SUPPLY	$3,235	$261	$3,496	$524	$350	$4,370	$656	$5,026
	AHU 14, RETURN	$1,396	$146	$1,542	$231	$154	$1,928	$289	$2,217
	AHU 16, SUPPLY	$420	$68	$488	$73	$49	$610	$91	$701
	AHU 16, RETURN	$292	$68	$360	$54	$36	$450	$67	$517
	AHU 17, SUPPLY	$366	$68	$434	$65	$43	$542	$81	$624
	COND PUMP#1								
	COND PUMP#2								
	COND PUMP#3	$3,853	$305	$4,158	$624	$416	$5,198	$780	$5,977
	CONST PRESS	$1,396	$146	$1,542	$231	$154	$1,928	$289	$2,217

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 17-Jul-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	COST MOTOR ($)	COST LABOR ($)	SUB TOTAL ($)	OH&B 15%	PROFIT 10%	SUB TOTAL ($)	CONT 15%	TOTAL ($)
200	CHWP#1								
CONT.	CHWP#2								
	CHWP#3	$1,639	$152	$1,791	$269	$179	$2,239	$336	$2,575
	CHWP#4								
	CHWP#4A	$3,235	$261	$3,496	$524	$350	$4,370	$656	$5,026
	CHWP#5								
	CHWP#6	$2,579	$229	$2,808	$421	$281	$3,510	$526	$4,036
	C TOWER#1	$2,579	$229	$2,808	$421	$281	$3,510	$526	$4,036
	C TOWER#2	$2,579	$229	$2,808	$421	$281	$3,510	$526	$4,036
	C TOWER#3								
	AIR COMP#1	$1,189	$141	$1,330	$199	$133	$1,662	$249	$1,912
	AIR COMP#2								
	HWP#1								
	HWP#2	$366	$68	$434	$65	$43	$542	$81	$624
	HWP#3								
	HWP#4	$420	$68	$488	$73	$49	$610	$91	$701
	HWP#5	$420	$68	$488	$73	$49	$610	$91	$701
	HWP#6								
	HWP#7	$366	$68	$434	$65	$43	$542	$81	$624
	HWP#8								
	HWP#9	$616	$72	$688	$103	$69	$861	$129	$990
	HWP#10								
	DCW PUMP#1	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	DCW PUMP#2								
	DCW PUMP#3								
	TOTAL								$96,825
206	DTWP#1	$616	$72	$688	$103	$69	$861	$129	$990
	DTWP#2	$616	$72	$688	$103	$69	$861	$129	$990
	TOTAL								$1,979
246	CW PUMP	$420	$68	$488	$73	$49	$610	$91	$701
	AHU	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	TOTAL								$2,282

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE:
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	COST MOTOR ($)	COST LABOR ($)	SUB TOTAL ($)	OH&B 15%	PROFIT 10%	SUB TOTAL ($)	CONT 15%	TOTAL ($)
358	AHU 1	$420	$68	$488	$73	$49	$610	$91	$701
	AHU 3	$292	$68	$360	$54	$36	$450	$67	$517
	AHU 4	$359	$68	$427	$64	$43	$534	$80	$614
	AHU 6	$366	$68	$434	$65	$43	$542	$81	$624
	HW PUMP	$359	$68	$427	$64	$43	$534	$80	$614
	CW PUMP	$366	$68	$434	$65	$43	$542	$81	$624
	TOTAL								$3,693
360	AHU	$616	$72	$688	$103	$69	$861	$129	$990
	TOTAL								$990
363	AHU 1	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	AHU 2	$616	$72	$688	$103	$69	$861	$129	$990
	AHU 3	$420	$68	$488	$73	$49	$610	$91	$701
	AHU 4	$420	$68	$488	$73	$49	$610	$91	$701
	AHU 5	$366	$68	$434	$65	$43	$542	$81	$624
	AHU 5A	$366	$68	$434	$65	$43	$542	$81	$624
	AHU 6	$420	$68	$488	$73	$49	$610	$91	$701
	AHU 7	$616	$72	$688	$103	$69	$861	$129	$990
	AHU 8	$616	$72	$688	$103	$69	$861	$129	$990
	AHU 9	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	AHU 10	$1,189	$141	$1,330	$199	$133	$1,662	$249	$1,912
	AHU 11								
	AHU 12	$366	$68	$434	$65	$43	$542	$81	$624
	AHU 13								
	CHWP#1	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	CHWP#2								
	HWP#1	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	COOLING TOWER	$616	$72	$688	$103	$69	$861	$129	$990
	COND PUMP#1	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	COND PUMP#2								
	TOTAL								$16,961
400	AHU 1	$328	$68	$396	$59	$40	$495	$74	$569
	AHU 2	$328	$68	$396	$59	$40	$495	$74	$569
	TOTAL								$1,138
401	AHU	$420	$68	$488	$73	$49	$610	$91	$701
	TOTAL								$701

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE:
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	COST MOTOR ($)	COST LABOR ($)	SUB TOTAL ($)	OH&B 15%	PROFIT 10%	SUB TOTAL ($)	CONT 15%	TOTAL ($)
500	AHU 1	$366	$68	$434	$65	$43	$542	$81	$624
	AHU 2	$420	$68	$488	$73	$49	$610	$91	$701
	AHU 3	$420	$68	$488	$73	$49	$610	$91	$701
	AHU 4	$359	$68	$427	$64	$43	$534	$80	$614
	AHU 5	$359	$68	$427	$64	$43	$534	$80	$614
	AHU 6	$292	$68	$360	$54	$36	$450	$67	$517
	AHU 7	$328	$68	$396	$59	$40	$495	$74	$569
	AHU 8	$359	$68	$427	$64	$43	$534	$80	$614
	EF 5	$366	$68	$434	$65	$43	$542	$81	$624
	CHW PUMP	$420	$68	$488	$73	$49	$610	$91	$701
	HW PUMP	$420	$68	$488	$73	$49	$610	$91	$701
	TOTAL								$6,979
514	AHU 3	$420	$68	$488	$73	$49	$610	$91	$701
	TOTAL								$701
522	CHWP	$359	$68	$427	$64	$43	$534	$80	$614
	HWP	$359	$68	$427	$64	$43	$534	$80	$614
	TOTAL								$1,227

RESEARCH OF PREMIUM EFFICIENCY MOTORS WITH SPEED CONTROLS:

A number of good articles on energy efficient motors and motor controls were reviewed. A list of these articles is provided below.

In regards to the question of, "Should energy efficient motors be used with variable speed controls?", one article stated:

> "When using adjustable-speed drives, it is best to specify the highest-efficiency motor possible. Inverters deliver a waveform that is less than an ideal pure sine wave. This chopped waveform causes more heating and losses in the motor. A motor with less losses can tolerate more impurities in input power without overheating. Heat is the ultimate enemy of motors, reducing life expectancy. For every 10oC higher running temperature, the life of the motor is cut in half. Premium-efficiency motors also run quieter and give a wider full-load speed range than normal motors operating on an adjustable-speed drive." ***Energy Efficiency In Electric Motors***, Darryl VanSon, Consulting/Specifying Engineer, November 1989.

In regards to the question of, "Is the improved efficiency due to the frequency of the motor or some other factors?", see is the attached article from General Electric, describing motor losses, construction of high-efficiency motors, and motor standards.

ARTICLES:

How to Select, Apply, and Install, Modern Motors and Controllers, Robert Lawrie, EC&M, June 1991.

Variable-Frequency Drives Take Hold In HVAC Market, Paul Beck, Consulting/Specifying Engineer, September 1991.

Applying AC Adjustable Frequency Drives to HVAC Systems, Kenneth A. Fanstad, Consulting Specifying Engineer, May 1989.

Energy Efficiency In Electric Motors, Darryl VanSon, Consulting/Specifying Engineer, November 1989.

Motor Selection Based Only On Purchase Price Can Be A Costly Mistake

Energy efficient motors represent an investment of 20 to 25% over the cost of standard, normal efficiency motors. While this premium can be recovered in a short period of time, the first objective should be to maximize the return on investment. To reach this goal, the motor user needs to understand motor efficiency, how it is achieved and how to conduct an economic evaluation. It is vital to evaluate the differences between motors offered by various manufacturers and only choose motors which clearly meet the user's operating criteria and cost reduction goals.

Understanding Motor Losses

Motor efficiency, as shown in Figure 1, is the watts output divided by the watts input. This is better expressed as the watts input minus the losses divided by the watts input.

$$\text{Efficiency} = \frac{746 \times \text{Hp Output}}{\text{Watts Input}} = \frac{\text{Input - Losses}}{\text{Input}}$$

Figure 1. Efficiency Equation

The only way to improve efficiency is to reduce motor losses. The components of motor losses can be broadly defined as no-load losses and load losses as shown in Figure 2.

	% Total
No Load Losses	
• Windage, Friction	14
• Core Losses	16
Load Losses	
• Stator I^2R Losses	33
• Rotor I^2R Losses	15
• Stray Load Losses	22
Total	100

Figure 2. Distribution of Losses

No load losses account for 30% of the total losses and include windage and friction losses plus core losses. The windage and friction losses are mechanical losses from bearing friction plus fan and rotor windage. Core losses are a combination of hysteresis and eddy current losses in the magnetic steel core.

Load losses account for the remaining 70% of the total losses and include stator and rotor I^2R losses and stray load losses. Stator losses are the product of stator input current (at load) squared and the stator resistance at operating temperature. Rotor losses result from rotor currents and are the product of the induced rotor current squared and the rotor resistance at operating temperature. Motor slip is a result of rotor losses.

Stray load losses are a result of additional harmonic and circulating current losses in the magnetic steel and windings. These losses are a result of design and manufacturing processes. Some of the factors which contribute to stray load losses are shown in Figure 3.

- **Number of Slots**
- **Stator and Rotor Slot Geometry**
- **Rotor Slot Insulation**
- **Air Gap Length**
- **Manufacturing Process Control**

Figure 3. Stray Load Loss Factors

Improving Efficiency Takes Know-how

The energy efficient motor design engineer strives for design optimization using techniques shown in Figure 4.

Most motors available today use a low carbon lamination steel for rotor and stator construction. This steel typically has 3.0 watts-per-pound of electrical losses and costs approximately the same as cold rolled steel. To reduce hysteresis and eddy current losses, manufacturers build energy efficient motors with high grade silicon steel. This steel has an electrical loss of 1.5 watts-per-pound and costs approximately 50% more than standard motor lamination steel.

- Improved Steel Properties
- Thinner Laminations
- Increased Wire Volume
- Improved Slot Designs
- More Steel
- Improved Rotor Insulation System
- More Efficient Fan Design

Figure 4. Efficiency Improvement

To further reduce eddy current losses, the high grade silicon steel is purchased in a thinner gauge than the low carbon lamination steel. Typical lamination thickness is .018 and .022 inches for the silicon and low carbon steel, respectively. In addition, the silicon steel has a surface coat of insulation to provide high inter-lamination resistance to eddy currents.

By increasing the volume of copper wire by 35 to 40%, the stator I^2R losses can be reduced. To accommodate this increase, slot areas must also be increased by as much as 50%. To compensate for the increase in slot size and corresponding decrease in active steel, the motor's rotor and stator core are lengthened. In addition to minimizing losses, this also reduces flux density and improves motor power factor. Nice additional benefits.

Rotor I^2R losses are improved through redesign of the rotor slots to increase the conductor cross section. In doing so, the rotor full load speed is increased slightly. The slot redesign must be made in such a way to continue to provide NEMA design B torques and locked rotor currents. This requires careful selection of the slot shape as well as the slot size.

Some of the losses in the motor are due to unplanned conduction paths which result from normal manufacturing processes. One such path is along the rotor surface where the rotor OD is turned down to provide a uniform air gap. Careful choice and control of the process are required to keep losses at a minimum.

Another such path is the current flow between rotor bars where the rotor is skewed. Skewing is a normal practice in small motors to reduce noise and torque pulsations. To minimize losses from inter-bar currents, the raw punched edges of the rotor slots are treated with a high temperature inorganic insulation before casting.

Because of the lower electromagnetic losses in an energy efficient motor, the motor does not require the same cooling as a standard motor design. This allows the designer to use a smaller fan to reduce windage and friction losses while achieving quieter operation.

In summary, by optimizing the design, motor losses are decreased and efficiency improvements are gained. As market conditions dictate and materials and technologies improve, further efficiency gains will be achieved.

Making The Standards Work For You

NEMA has adopted an efficiency labeling standard based upon probabilities (MG 1-12.54.2) which will help the buyer get what he is paying for. The bell-shaped curve shown in Figure 5, assumes that, once the nominal value of efficiency is defined for a specific motor design, half of the motors will be above that value and half below.

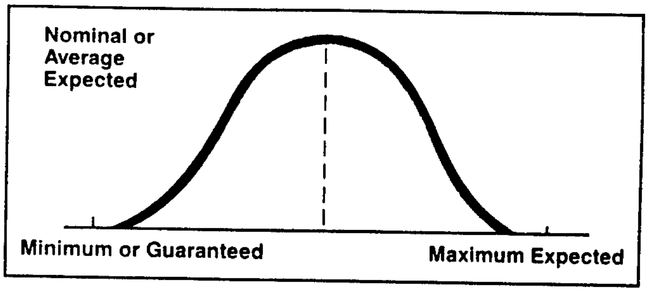


Figure 5. Motor Efficiency

The standard, which applies to NEMA designs A and B, single speed, polyphase, squirrel-cage, integral-Hp motors in the 1 through 125 horsepower sizes, calls for the nominal efficiency to be identified on the motor nameplate. This standard recognizes that variations in materials, manufacturing processes and test results cause motor to motor efficiency variations for a given design. Therefore, the full-load efficiency for a large population of motors of a given design is not a unique value but rather a band of efficiencies. The standard defines the minimum and nominal efficiency to expect from a motor design for a population of motors and

the manufacturer must select from the values in Figure 6. GE motors exceed these standards.

Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
98.0	97.6	87.5	85.5
97.8	97.4	86.5	84.0
97.6	97.1	85.5	82.5
97.4	96.8	84.0	81.5
97.1	96.5	82.5	80.0
96.8	96.2	81.5	78.5
96.5	95.8	80.0	77.0
96.2	95.4	78.5	75.5
95.8	95.0	77.0	74.0
95.4	94.5	75.5	72.0
95.0	94.1	74.0	70.0
94.5	93.6	72.0	68.0
94.1	93.0	70.0	66.0
93.6	92.4	68.0	64.0
93.0	91.7	66.0	62.0
92.4	91.0	64.0	59.5
91.7	90.2	62.0	57.5
91.0	89.5	59.5	55.0
90.2	88.5	57.5	52.5
89.5	87.5	55.0	50.5
88.5	86.5	52.5	48.0
		50.5	46.0

Figure 6. NEMA Efficiency Marking Standard

This standard establishes the nominal efficiency values that are to be used on the motor nameplate, the motor manufacturer selects the value range for a given design from the table.

NEMA standard MG 1-12.55 specifies efficiency levels for polyphase squirrel-cage induction motors to be classified as energy efficient. The nominal full-load efficiency as determined in accordance with MG 1-12.54.1 (IEEE test procedure 112, method B) and identified on the nameplate in accordance to the labeling standard MG 1-12.54.2, must equal or exceed the values shown in appendix "A" for the motor to be classified as energy efficient.

Specifying Guaranteed Values Is Best

Buyers who only specify the nominal efficiency value for new energy efficient motor purchases are relying on the manufacturer to consistently provide motors within the band defined in the NEMA standards. By specifying and evaluating motors at the guaranteed minimum efficiency, the buyer can feel confident that his economic evaluation is conservative but reasonable. The buyer also has a basis to reject any motor which does not meet the guarantee.

The motor user who specifies and evaluates on guaranteed minimum efficiency values will discourage casual efficiency claims and can select a motor supplier with confidence.

The Energy Efficient Motor Decision

Specification and installation of energy efficient motors can yield attractive economic results compared to standard efficiency designs for the same installation.

To fully understand these benefits, the buyer can make either a simple payback calculation or a comprehensive economic evaluation including a life cycle cost analysis. Typically, as the quantity of motors increases and the value of the installation grows, a more detailed analysis is performed.

How To Calculate Annual Savings

In comparing the efficiencies of two motors, the buyer must consider the type of motors involved, the annual hours of operation, motor load, electrical costs and the motor efficiencies. These basic data apply whether the comparison is between a standard and an energy efficient design or between two energy efficient designs with different efficiencies. Regardless of the comparison, it is essential that the efficiency values be on the same basis — you must compare nominal vs. nominal or guaranteed vs. guaranteed.

With that in mind, the equation in Figure 7 can be used to determine annual savings for two 50 horsepower, 1800 rpm, totally-enclosed, fan-cooled, severe-duty motors operating at rated load. The nominal efficiency value for the standard efficiency motor is 91.7 while the comparable value for the energy efficient motor is 94.1. If operated continuously (8760 hours) with an electrical cost of $.0512/kWh, the annual savings would be $465.

INSTALL HIGH EFFICIENCY MOTORS

MOTORS OPERATING AT FULL LOAD (1800 RPM)

ELEC. COST: $0.0255 /kWH
DEMAND COST: $8.85 /kW

				HOURS OF OPERATION PER YEAR					
				2000 HRS		4000 HRS		8760 HRS	
H.P.	STANDARD EFFICIENCY	PREMIUM EFFICIENCY	DIFFERENTIAL COST *	SAVINGS/ YEAR	SIMPLE PAYBACK	SAVINGS/ YEAR	SIMPLE PAYBACK	SAVINGS/ YEAR	SIMPLE PAYBACK
1	77.0%	86.5%	$148	$14	10.6	$19	8.0	$29	5.0
1.5	77.0%	86.5%	$167	$21	8.0	$28	6.0	$44	3.8
2	80.0%	86.5%	$178	$18	9.7	$24	7.3	$39	4.6
3	84.0%	88.5%	$172	$18	9.7	$24	7.3	$38	4.6
5	85.5%	89.5%	$201	$25	7.9	$34	5.9	$54	3.7
7.5	86.5%	91.7%	$305	$48	6.4	$64	4.8	$102	3.0
10	87.5%	91.7%	$370	$51	7.3	$68	5.4	$108	3.4
15	88.5%	92.4%	$495	$70	7.1	$93	5.3	$148	3.3
20	90.2%	93.0%	$579	$65	8.9	$87	6.7	$138	4.2
25	90.2%	93.6%	$646	$98	6.6	$131	4.9	$208	3.1
30	90.2%	94.1%	$729	$134	5.4	$179	4.1	$285	2.6
40	91.0%	94.1%	$1,042	$141	7.4	$188	5.5	$299	3.5
50	91.7%	94.5%	$1,214	$157	7.7	$210	5.8	$334	3.6
60	91.7%	94.5%	$1,515	$189	8.0	$252	6.0	$401	3.8
75	92.2%	94.5%	$1,743	$193	9.0	$257	6.8	$409	4.3
100	93.0%	94.6%	$2,666	$177	15.0	$236	11.3	$376	7.1

* DIFFERENTIAL COST DOES NOT INCLUDE LABOR COSTS

APPENDIX C-6

ADD ECONOMIZERS

E M C ENGINEERS, INC.
PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: ECONOMIZERS

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 07/17/92
FILE: ECONO.WK3
PRPARED BY: DENNIS JONES
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
INCREMENTAL GAS COST	$4.67 MBtu	19.64 UPWG
INCREMENTAL ELECTRIC COST	$0.0255 kWh	15.23 UPWE
ELECTRIC DEMAND CHARGE	$102.66 kW	14.68 UPW
ECONOMIC LIFE	15 YRS	

BUILDING NUMBER	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWH)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND SAVINGS ($)	ANNUAL NON-ENE SAVINGS ($)	TOTAL ANNUAL SAVINGS ($)	CONST. COST ($)	SIR	SIMPLE PAYBACK (YRS)
181	0	6,198	0	21	158	0	0	158	19,688	0.1	124.6
184	0	4,737	0	16	121	0	0	121	18,746	0.1	155.2
246	0	1,570	0	5	40	0	0	40	30,708	0.0	767.0
514	0	305	0	1	8	0	0	8	25,461	0.0	3273.7

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

[X] CODE A [ ] CODE B [ ] CODE C [ ] OTHER

EFFECTIVE PRICING DATE APR 92

DRAWING NO.

ESTIMATOR RMG

DATE PREPARED 16-Apr-92

SHT OF

CHECKED BY CEL

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

ECO 6 - Economizers	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
OPPOSED BLADE DAMPERS (2)	1	MCFM	1	1	$21.17	$21.17			$80.00	$80.00	$101.17		
LOUVERS, GALVANIZED	1	MCFM	1	1	$21.17	$21.17			$58.00	$58.00	$79.17		
DAMPER OPERATOR, ELECTRIC	2	EA	1.33	2.66	$20.88	$55.54			$150.00	$300.00	$355.54		
DTS	3	EA	2	6	$21.17	$127.02			$160.00	$480.00	$607.02		
STS	2	EA	1.5	3	$21.17	$63.51			$118.00	$236.00	$299.51		
PROGRAMMING	7	EA			$150.00	$1,050.00					$1,050.00		
WIRE & CONDUIT	7	EA							94	$658.00	$658.00		
CONTROLLER	1	EA							1,100	$1,100.00	$1,100.00		
SHEET METAL MODIFICATION	1	EA	8	8	$20.88	$167.04					$167.04		
SUBTOTAL						$1,505.45				$2,912.00	$4,417.45		
OVERHEAD, BOND	15%					$225.82				$436.80	$662.62		
PROFIT	10%					$150.55				$291.20	$441.75		
COST SUB-TOTAL						$1,881.81				$3,640.00	$5,521.81		
CONTINGENCY	15%					$282.27				$546.00	$828.27		
TOTAL						$2,164.09				$4,186.00	$6,350.09		

DA FORM 5418-R, APR 86

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study
LOCATION Ft. McPherson & Ft Gillem

INVITATION NO./CONTRACT NO.
DACA 21-91-C-0097
X CODE A ☐ CODE B ☐ CODE C ☐ OTHER

EFFECTIVE PRICING DATE APR 92
DRAWING NO.
ESTIMATOR RMG

DATE PREPARED 22-Apr-92
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ECO-6, ECONOMIZERS	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
BLDG. 181													
AHU-1, 14,280 CFM													
EXISTING ECONOMIZER													
AHU-2, 4290 CFM													
OPPOSED BLADE DAMPERS (2)	4	MCFM	1	4.29	$21.17	$90.82			$80.00	$343.20	$434.02		
LOUVERS, GALVANIZED	4	MCFM	1	4.29	$21.17	$90.82			$58.00	$248.82	$339.64		
DAMPER OPERATOR, ELECTRIC	2	EA	1.33	2.66	$21.17	$56.31			$150.00	$300.00	$356.31		
DTS	3	EA	2	6	$21.17	$127.02			$160.00	$480.00	$607.02		
STS	2	EA	1.5	3	$21.17	$63.51			$118.00	$236.00	$299.51		
PROGRAMMING	7	EA			$150.00	$1,050.00					$1,050.00		
WIRE & CONDUIT	7	EA							94	$658.00	$658.00		
CONTROLLER	1	EA							1,100	$1,100.00	$1,100.00		
DUCTWORK 24"X48"X10'	120	LBM	0.102	12.24	$20.88	$2,505.60			$0.74	$88.80	$2,594.40		
AHU-3, 4200 CFM													
OPPOSED BLADE DAMPERS (2)	4	MCFM	1	4.29	$21.17	$90.82			$80.00	$343.20	$434.02		
LOUVERS, GALVANIZED	4	MCFM	1	4.29	$21.17	$90.82			$58.00	$248.82	$339.64		
DAMPER OPERATOR, ELECTRIC	2	EA	1.33	2.66	$21.17	$56.31			$150.00	$300.00	$356.31		
DTS	3	EA	2	6	$21.17	$127.02			$160.00	$480.00	$607.02		
STS	2	EA	1.5	3	$21.17	$63.51			$118.00	$236.00	$299.51		
PROGRAMMING	7	EA			$150.00	$1,050.00					$1,050.00		
WIRE & CONDUIT	7	EA							94	$658.00	$658.00		
CONTROLLER	1	EA							1,100	$1,100.00	$1,100.00		
SUBTOTAL						$5,462.56				$6,820.84	$12,283.40		
OVERHEAD, BOND	15%					$819.38				$1,023.13	$1,842.51		
PROFIT	10%					$546.26				$682.08	$1,228.34		
COST SUB-TOTAL						$6,828.20				$8,526.05	$15,354.25		
CONTINGENCY	15%					$1,024.23				$1,278.91	$2,303.14		
TOTAL						$7,852.43				$9,804.96	$17,657.39		

DA FORM 5418-R, APR 85

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

X CODE A ☐ CODE B ☐ CODE C ☐ OTHER

EFFECTIVE PRICING DATE APR 92 | DATE PREPARED 22-Apr-92

DRAWING NO. | SHT OF

ESTIMATOR RMG | CHECKED BY CEL

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

ECO-6, ECONOMIZERS	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
BLDG. 184													
AHU 1 – 10, 24,500 CFM													
OPPOSED BLADE DAMPERS (2)	25	MCFM	1	24.5	$21.17	$518.67			$80.00	$1,960.00	$2,478.67		
LOUVERS, GALVANIZED	25	MCFM	1	24.5	$21.17	$518.67			$58.00	$1,421.00	$1,939.67		
DAMPER OPERATOR, ELECTRIC	20	EA	1.33	26.6	$21.17	$563.12			$150.00	$3,000.00	$3,563.12		
DTS	3	EA	2	6	$21.17	$127.02			$160.00	$480.00	$607.02		
STS	2	EA	1.5	3	$21.17	$63.51			$118.00	$236.00	$299.51		
PROGRAMMING	7	EA			$150.00	$1,050.00					$1,050.00		
WIRE & CONDUIT	7	EA							94	$658.00	$658.00		
CONTROLLER	1	EA							1,100	$1,100.00	$1,100.00		
SUBTOTAL						$2,840.98				$8,855.00	$11,695.98		
OVERHEAD, BOND	15%					$426.15				$1,328.25	$1,754.40		
PROFIT	10%					$284.10				$885.50	$1,169.60		
COST SUB-TOTAL						$3,551.23				$11,068.75	$14,619.98		
CONTINGENCY	15%					$532.68				$1,660.31	$2,193.00		
TOTAL						$4,083.91				$12,729.06	$16,812.97		

DA FORM 5418-R, APR 85

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ESTIMATOR RMG

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PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

ECO-6, ECONOMIZERS BLDG 246	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
MULTIZONE UNIT, 19500 CFM													
OPPOSED BLADE DAMPERS (2)	20	MCFM	1	19.5	$21.17	$412.82			$80.00	$1,560.00	$1,972.82		
LOUVERS, GALVANIZED	20	MCFM	1	19.5	$21.17	$412.82			$58.00	$1,131.00	$1,543.82		
DAMPER OPERATOR, ELECTRIC	8	EA	1.33	10.64	$21.17	$225.25			$150.00	$1,200.00	$1,425.25		
DTS	3	EA	2	6	$21.17	$127.02			$160.00	$480.00	$607.02		
STS	2	EA	1.5	3	$21.17	$63.51			$118.00	$236.00	$299.51		
PROGRAMMING	7	EA			$150.00	$1,050.00					$1,050.00		
WIRE & CONDUIT	7	EA							94	$658.00	$658.00		
CONTROLLER	1	EA							1,100	$1,100.00	$1,100.00		
DUCTWORK, 4'X8'X20'	480	LB	0.102	48.96	$20.88	$10,022.40			1	$480.00	$10,502.40		
NOTE: USE FAN ROOM AS PLENUM													
SUBTOTAL						$12,313.81				$6,845.00	$19,158.81		
OVERHEAD, BOND	15%					$1,847.07				$1,026.75	$2,873.82		
PROFIT	10%					$1,231.38				$684.50	$1,915.88		
COST SUB-TOTAL						$15,392.26				$8,556.25	$23,948.51		
CONTINGENCY	15%					$2,308.84				$1,283.44	$3,592.28		
TOTAL						$17,701.10				$9,839.69	$27,540.79		

DA FORM 5418-R, APR 85

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study
LOCATION Ft. McPherson & Ft Gillem

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097
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[ ] OTHER

EFFECTIVE PRICING DATE APR 92
DRAWING NO.
ESTIMATOR RMG

DATE PREPARED 22-Apr-92
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ECO-6, ECONOMIZERS BLDG 514	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
AHU 1 – 3,													
OPPOSED BLADE DAMPERS (2)	8	MCFM	1	8.3	$21.17	$175.71			$80.00	$664.00	$839.71		
LOUVERS, GALVANIZED	8	MCFM	1	8.3	$21.17	$175.71			$58.00	$481.40	$657.11		
DAMPER OPERATOR, ELECTRIC	6	EA	1.33	7.98	$21.17	$168.94			$150.00	$900.00	$1,068.94		
DTS	9	EA	2	18	$21.17	$381.06			$160.00	$1,440.00	$1,821.06		
STS	6	EA	1.5	9	$21.17	$190.53			$118.00	$708.00	$898.53		
PROGRAMMING	21	EA			$150.00	$3,150.00					$3,150.00		
WIRE & CONDUIT	21	EA							94	$1,974.00	$1,974.00		
CONTROLLER	1	EA							1,100	$1,100.00	$1,100.00		
DUCTWORK, 2'X3'X20'	200	LB	0.102	20.4	$20.88	$4,176.00			1	$200.00	$4,376.00		
SUBTOTAL						$8,417.95				$7,467.40	$15,885.35		
OVERHEAD, BOND	15%					$1,262.69				$1,120.11	$2,382.80		
PROFIT	10%					$841.79				$746.74	$1,588.53		
COST SUB-TOTAL						$10,522.44				$9,334.25	$19,856.69		
CONTINGENCY	15%					$1,578.37				$1,400.14	$2,978.50		
TOTAL						$12,100.80				$10,734.39	$22,835.19		

DA FORM 5418-R, APR 85

APPENDIX C-7

CONTROL HOT WATER CIRCULATION PUMPS

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: MECO15
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-7 HOT WATER PUMPS
ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	29603.
B. SIOH	$	1629.
C. DESIGN COST	$	1777.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	33009.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	440.	$ 3288.	11.11	36534.
B. DIST	$ .00	0.	$ 0.	14.26	0.
C. RESID	$ .00	0.	$ 0.	16.89	0.
D. NAT G	$ 4.67	876.	$ 4091.	14.45	59114.
E. COAL	$ .00	0.	$ 0.	11.21	0.
F. TOTAL		1316.	$ 7379.		$ 95648.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 10.59
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 31564.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 7379.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 95648.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 2.90
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 4.47

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 7 – Hot Water Pumps

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 16-Jul-92
FILE: ECO-7.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	14.45 UPWG
Electric Savings	$0.0255 / kWh	11.11 UPWE
Demand Savings	$8.85 / kW	10.59 UPW

Economic Life: 15 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON-ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
500	0	33,679	378	493	$2,624	$0	$0	$2,624	$11,003	3.2	4.2
170	0	47,639	249	411	$2,378	$0	$0	$2,378	$11,003	2.8	4.6
171	0	47,639	249	411	$2,378	$0	$0	$2,378	$11,003	2.8	4.6
TOTAL	0	128,957	876	1,316	$7,379	$0	$0	$7,379	$33,008	2.9	4.5
184	0	6,245	120	141	$720	$0	$0	$720	$11,003	0.9	15.3

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

[ ] CODE A [X] CODE B [ ] CODE C
[ ] OTHER

EFFECTIVE PRICING DATE APR. 91

DRAWING NO.

ESTIMATOR CEL

DATE PREPARED 22-Apr-92

SHT OF

CHECKED BY CEL

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

HW PUMP CONTROL	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
WTS	2	EA	5.0	10.0	21.17	$211.70			261.0	522.00	734		
STS	1	EA	1.5	1.5	21.17	$31.76			118	118.00	150		
VALVE	1	EA	2.0	2.0	21.17	$42.34			370	370.00	412		
ST/SP	1	EA	2.0	2.0	21.17	$42.34			66	66.00	108		
PUMP DPS	1	EA	2.5	2.5	21.17	$52.93			129	129.00	182		
WIRE AND CONDUIT	6								$94.00	$564.00	$564.00		
PROGRAMMING	6					$900.00					$900.00		
SUBTOTAL						$1,281				$1,769	$3,050		
OVERHEAD, BOND	15%					$192				$265	$458		
PROFIT	10%					$128				$177	$305		
COST SUB-TOTAL						$1,601				$2,211	$3,813		
CONTINGENCY	15%					$240				$332	$572		
CONTROLLER										$1,100	$1,100		
TOTAL THIS SHEET						$1,842				$3,643	$5,484		

DA FORM 5418-R, APR 85

APPENDIX C-8

INSTALL LOW-FLOW SHOWER AND FAUCET FIXTURES

LIFE CYCLE COST ANALYSIS SUMMARY
STUDY: MECO15
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-8 WATER FLOW RESTRICTORS
ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT		
A. CONSTRUCTION COST	$	9826.
B. SIOH	$	541.
C. DESIGN COST	$	590.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	10957.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	0.	$ 0.	11.11	0.
B. DIST	$ .00	0.	$ 0.	14.26	0.
C. RESID	$ .00	0.	$ 0.	16.89	0.
D. NAT G	$ 4.67	1001.	$ 4675.	14.45	67549.
E. COAL	$ .00	0.	$ 0.	11.21	0.
F. TOTAL		1001.	$ 4675.		$ 67549.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 6495.
(1) DISCOUNT FACTOR (TABLE A) 10.59
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 68782.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 68782.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 22291.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) 8.20
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 11170.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 136331.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 12.44
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 .98

WATER FLOW RESTRICTORS SAMPLE CALCULATION, ECO #8
BUILDING 60

Given:

# of people	= 48 people	-from field survey
Water heater efficiency	= 70%	-assumed
Gas cost	= $4.67 / MBtu	-from utility rate analysis
Water Cost	= $2.39 / 1000 gals	-from utility rate analysis

Showers:

# of showers	= 18 showers	-from field survey
Existing water flow	= 3.75 gpm	-from field survey
Improved water flow	= 1.6 gpm	-from field survey
Usage	= (7 min/person day)*(365 days/year)	
	= 2,555 min/person yr	-assumed
Shower water temperature	= 102°F	-assumed
Supply water temperature	= 66°F	-from City of Atlanta info

Faucets:

# of faucets	= 36 faucets	-from field survey
Existing water flow	= 2.25 gpm	-from field survey
Improved water flow	= 0.40 gpm	-from field survey
Usage	= (5 min/person day)*(365 days/year)	
	= 1,825 min/person yr	-assumed
Faucet water temperature	= 80°F	-assumed
Supply water temperature	= 66°F	-from City of Atlanta info

Annual Existing Flow:

Showers:
(48 people)*(3.75 gpm)*(2,555 min/yr) = 459,900 gal/yr
Faucets:
(48 people)*(2.25 gpm)*(1,825 min/yr) = 197,100 gal/yr
Total:
459,900 gal/yr + 197,100 gal/yr = 657,000 gal/yr

Annual Improved Flow:

Showers:
(48 people)*(1.6 gpm)*(2,555 min/yr) = 196,224 gal/yr
Faucets:
(48 people)*(0.40 gpm)*(1,825 min/yr) = 35,040 gal/yr
Total:
196,224 gal/yr + 35,040 gal/yr = 231,264 gal/yr

Annual Non-Energy Savings:

Showers:
459,900 gal/yr - 196,224 gal/yr = 263,676 gal/yr
Faucets:
197,100 gal/yr - 35,040 gal/yr = 162,060 gal/yr
Total:
657,000 gal/yr - 231,264 gal/yr = 425,736 gal/yr

Annual Energy Savings:

Showers:
(263,676 gal/yr)*(8.33 lbs/gal)*(1 Btu/lb °F)*(102°F - 66°F)/70%
= 113.0 MBtu/yr
Faucets:
(162,060 gal/yr)*(8.33 lbs/gal)*(1 Btu/lb °F)*(80°F - 66°F)/70%
= 27.0 MBtu/yr
Total:
113 MBtu/yr + 27 MBtu/yr = 140 MBtu/yr

Annual Cost Savings

($4.67/MBtu)*(140 MBtu/yr) + ($2.39/1000 gal)*(425,736 gal/yr)
= $1,671/yr

Estimated Construction Cost:

$31.74/shower	-from engineer's cost estimate
$17.36/faucet	-from engineer's cost estimate

($31.74/ea)*(18 showers) + ($17.36/ea)*(36 faucets)
= $1,196

$1,196 + ($1,196 * .055 SIOH) + ($1,196 * .06 DESIGN) = $1,334

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 8 – Water Flow Restrictors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 17-Jul-92
FILE: ECO-8.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	14.45 UPWG
Electric Savings	$0.0255 / kWh	11.11 UPWE
Demand Savings	$8.85 / kW	10.59 UPW
Water Savings	$2.390 / 1000 gals	10.59 UPW

Economic Life: 15 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON-ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
401	0	0	159	159	$741	$0	$885	$1,627	$425	47.3	0.3
109	0	0	52	52	$244	$0	$448	$692	$238	34.7	0.3
56	0	0	131	131	$611	$0	$803	$1,414	$889	19.5	0.6
58	0	0	131	131	$611	$0	$803	$1,414	$889	19.5	0.6
62	0	0	131	131	$611	$0	$803	$1,414	$889	19.5	0.6
60	0	0	140	140	$654	$0	$1,018	$1,671	$1,334	15.2	0.8
28	0	0	41	41	$191	$0	$298	$488	$445	13.3	0.9
363	0	0	44	44	$204	$0	$244	$449	$425	13.0	0.9
40	0	0	68	68	$319	$0	$476	$795	$934	10.3	1.2
168	0	0	76	76	$354	$0	$499	$853	$1,044	10.0	1.2
27	0	0	29	29	$134	$0	$220	$354	$445	9.6	1.3
									$7,956		
Include $3000 cost for administation of small contract									$3,000		
TOTAL	0	0	790	790	$3,689	$0	$5,162	$8,851	$10,956	9.9	1.2

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 8 – **WATER FLOW RESTRICTORS**

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

COST SAVINGS:
WATER $2.390 / 1000 gals

EMC PROJECT: #3105.000
DATE: 22-APR-92
FILE: ECO8.WK3
PREPARED BY: CHRIS STANLEY
CHECKED BY:

		SHOWER FLOW RESTRICTORS									
BLDG #	# PEOPLE	# SHOWERS / BLDG	USAGE / PERSON / YEAR (min/yr)	EXIST FLOW RATE (gpm)	IMPRVD FLOW RATE (gpm)	TOTAL EXIST FLOW (gal/yr)	TOTAL IMPRVD FLOW (gal/yr)	WATER TEMP SHOWER (°F)	WATER TEMP SUPPLY (°F)	# FAUCETS / BLDG	USAGE /PERSON / YEAR (min/yr)
027	20	6	2555	2.50	1.50	127,750	76,650	102	66	12	1,825
028	20	6	2555	3.00	1.50	153,300	76,650	102	66	12	1,825
40	30	16	2555	3.25	1.50	249,113	114,975	102	66	19	1,825
56	32	12	2555	5.00	1.50	408,800	122,640	102	66	24	1,825
58	32	12	2555	5.00	1.50	408,800	122,640	102	66	24	1,825
60	48	18	2555	3.75	1.60	459,900	196,224	102	66	36	1,825
62	32	12	2555	5.00	1.50	408,800	122,640	102	66	24	1,825
109	18	4	2555	3.50	1.75	160,965	80,483	102	66	5	1,825
168	34	18	2555	3.20	1.40	277,984	121,618	102	66	21	1,825
363	20	12	2555	3.75	1.75	191,625	89,425	102	66		
401	40	12	2555	5.63	2.00	574,875	204,400	102	66		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 8 – WATER FLOW RESTRICTORS

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 22-APR-92
FILE: ECO8.WK3
PREPARED BY: CHRIS STANLEY
CHECKED BY:

COST SAVINGS:
WATER $2.390 / 1000 gals

FAUCET FLOW RESTRICTORS						SAVINGS				COST		
EXIST FLOW RATE (gpm)	IMPRVD FLOW RATE (gpm)	TOTAL EXIST FLOW (gal/yr)	TOTAL IMPRVD FLOW (gal/yr)	WATER TEMP FAUCET (°F)	WATER TEMP SUPPLY (°F)	WATER HEATER EFF	ANNUAL GAS SAVED (MBtu/yr)	ANNUAL WATER SAVED (gal/yr)	ANNUAL WATER SAVED ($/yr)	SHOWER CONST COST ($/ea)	FAUCET CONST COST ($/ea)	TOTAL CONST COST ($)
2.25	1.13	82,125	41,063	80	66	70%	28.7	92,163	$220	$31.74	$17.36	$399
1.88	0.56	68,438	20,531	80	66	70%	40.8	124,556	$298	$31.74	$17.36	$399
1.75	0.56	95,813	30,797	80	66	70%	68.3	199,153	$476	$31.74	$17.36	$838
1.35	0.50	78,840	29,200	80	66	70%	130.9	335,800	$803	$31.74	$17.36	$798
1.35	0.50	78,840	29,200	80	66	70%	130.9	335,800	$803	$31.74	$17.36	$798
2.25	0.40	197,100	35,040	80	66	70%	140.0	425,736	$1,018	$31.74	$17.36	$1,196
1.35	0.50	78,840	29,200	80	66	70%	130.9	335,800	$803	$31.74	$17.36	$798
3.75	0.50	123,188	16,425	80	66	70%	52.3	187,245	$448	$31.74	$17.36	$214
1.88	1.03	116,344	63,912	80	66	70%	75.7	208,798	$499	$31.74	$17.36	$936
						70%	43.8	102,200	$244	$31.74	$17.36	$381
						70%	158.7	370,475	$885	$31.74	$17.36	$381

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study LOCATION Ft. McPherson & Ft Gillem	INVITATION NO./CONTRACT NO. DACA 21-91-C-0097 [X] CODE A [ ] CODE B [ ] CODE C [ ] OTHER	EFFECTIVE PRICING DATE APR 92 DRAWING NO. ESTIMATOR RMG	DATE PREPARED 15-Apr-92 SHT OF CHECKED BY

	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
ECO 8 – Water Flow Restrictors TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
LOW FLOW SHOWER HEAD	1	EA	0.330	0.330	$21.45	$7.08			$15.00	$15.00	$22.08		
SUBTOTAL						$7.08					$22.08		
OVERHEAD, BOND	15%					$1.06					$3.31		
PROFIT	10%					$0.71					$2.21		
COST SUB-TOTAL						$8.85					$27.60		
CONTINGENCY	15%					$1.33					$4.14		
TOTAL						$10.18					$31.74		
LOW FLOW FAUCET	1	EA	0.330	0.330	$21.45	$7.08			$5.00	$5.00	$12.08		
SUBTOTAL						$7.08					$12.08		
OVERHEAD, BOND	15%					$1.06					$1.81		
PROFIT	10%					$0.71					$1.21		
COST SUB-TOTAL						$8.85					$15.10		
CONTINGENCY	15%					$1.33					$2.26		
TOTAL						$10.18					$17.36		

DA FORM 5418-R, APR 85

JOB 3105.000 / ESOS

E M C ENGINEERS, INC.

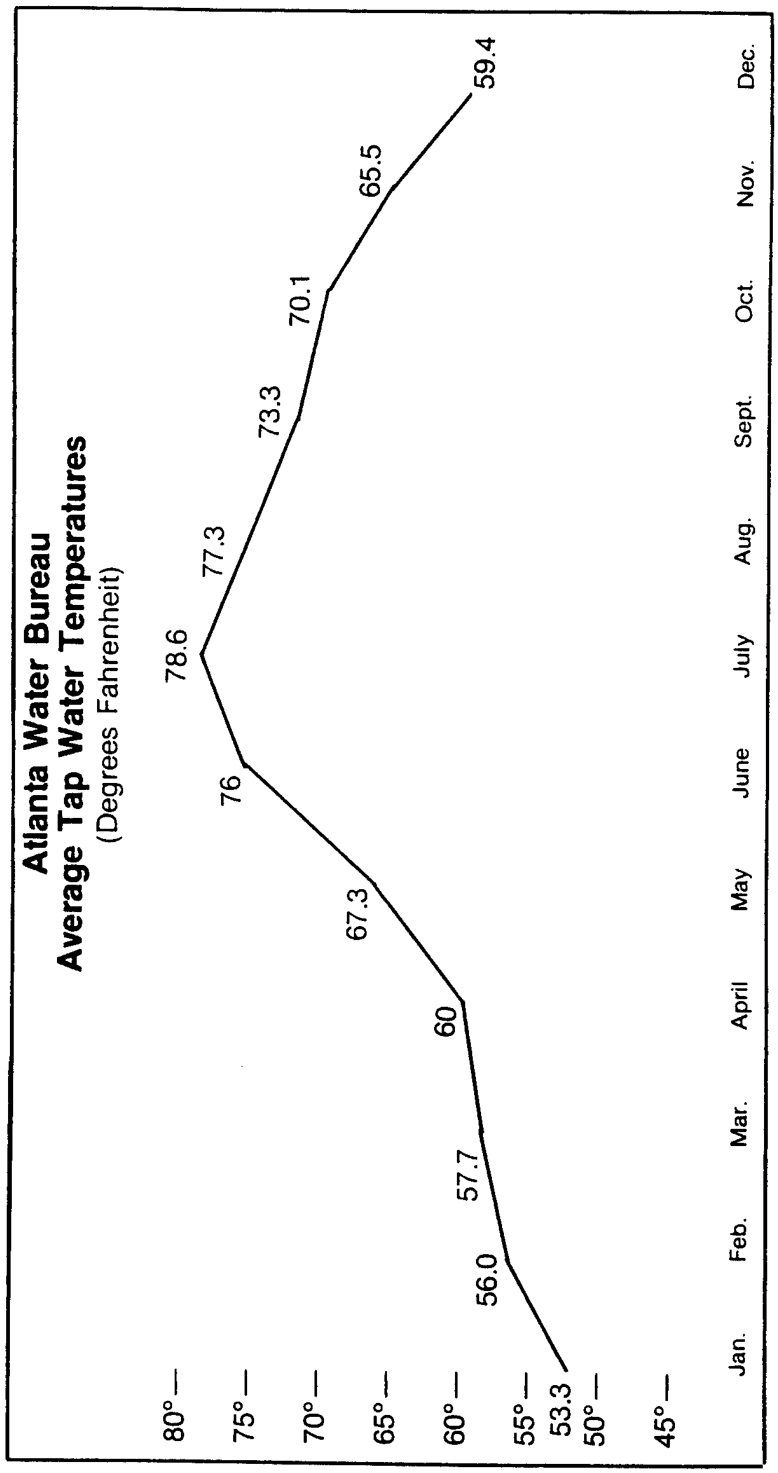
Denver • Colorado Springs • Atlanta • Germany

SHEET NO. ______ OF ______

CALCULATED BY CEL DATE 4/21/92

CHECKED BY ______ DATE ______

SCALE ______



9

MEAN = 66 °F

APPENDIX C-9

HEAT RECLAIM FOR HOT REFRIGERANT GAS

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: HEAT RECLAIM FROM HOT REFRIGERANT GAS

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 07/17/92
FILE: HOTGAS.WK3
PRPARED BY: DENNIS JONES
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
INCREMENTAL GAS COST	$4.67 MBtu	14.45 UPWG
INCREMENTAL ELECTRIC COST	$0.0256 kWh	11.11 UPWE
ELECTRIC DEMAND CHARGE	$102.66 kW	10.59 UPW
ECONOMIC LIFE	15 YRS	

BUILDING NUMBER	FLOOR AREA (ft2)	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWH)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND SAVINGS ($)	ANNUAL NON-ENE SAVINGS ($)	TOTAL ANNUAL SAVINGS ($)	CONST. COST ($)	SIR	SIMPLE PAYBACK (YRS)
500		0	0	158	158	$738	$0	$0	$738	$16,579	0.6	22.5

BLDG. 500

Assume

1) 7.5 ton chiller on 10' * 10' walk in cooler
2) Assume 50% operation * 2 chillers = 7.5 tons.
3) Desuperheaters will produce 2600 Btuh/ton in heating water from 75 °F to 140 °F.

For one day, hot water produced is:

$$\frac{2 * 0.50 * 7.5 \text{ tons} * 2600 \text{ Btu lbm °F gal} * 24 \text{ hrs}}{(140 - 75) \text{ °F hr ton Btu} * 8.3 \text{ lbm}} = 867 \text{ gallons available heat}$$

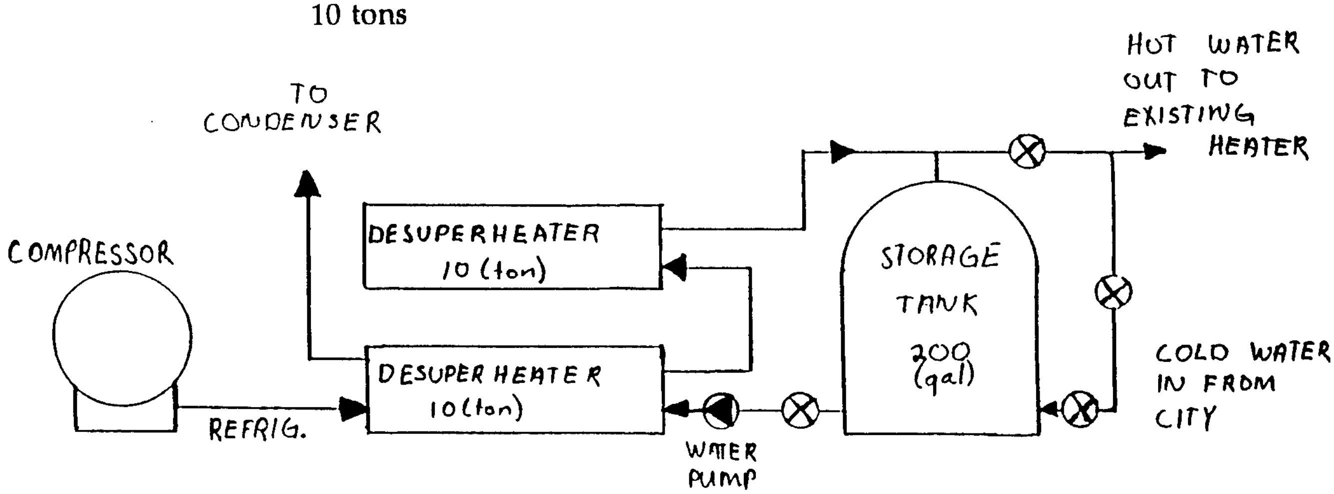
Resturants use 2.4 gallons per meal (ASHRAE HVAC 1991 44.10).

250 meals / day * 2.4 gal / meal = 600 gallons HW Demand
Heat reclaimed overnight must be stored, use 50%, 300 gallons storage capacity.

Maximum heat production:

For 10 ton unit, 75 °F - 140 °F heat gain: $\frac{10 \text{ ton} * 2{,}600 \text{ Btuh}}{500 * 52 \text{ °F}} = 0.8$ gpm

$$\frac{7.5 \text{ tons} * 2 \text{ chillers} * .8 \text{ gpm}}{10 \text{ tons}} = 1.2 \text{ gpm pump size}$$



$$\text{Gas saved} = \frac{600 \text{ gal} * (140 - 75) \text{ °F} * 8.3 \text{ lbs} * \text{Btu} * 365 \text{ days} * \text{MBtu}}{\text{°F} * \text{gal} * .75 * \text{yr} * 1{,}000{,}000 \text{ Btu}} = 157.75 \text{ MBtu / yr}$$

E M C ENGINEERS, INC.
Denver • Colorado Springs • Atlanta • Germany

JOB Ft. McPherson / Ft. Gillem ESOS Study

SHEET NO. EMC # 3105.000 OF

CALCULATED BY DATE

CHECKED BY DATE

SCALE

	75 °F - 140 °F DELTA T		115 °F - 140 °F DELTA T	
CHILLER SIZE (tons)	FLUID FLOW (gpm)	HEAT PROD. (Btuh)	FLUID FLOW (gpm)	HEAT PROD. (Btuh)
10	0.8	26,000	1.9	23,750
20	1.6	52,000	3.8	47,500
30	2.4	78,000	5.7	71,250
40	3.2	104,000	7.6	95,000
50	4.0	130,000	9.5	118,750
60	4.8	156,000	11.4	142,500
70	5.6	182,000	13.3	166,250
80	6.4	208,000	15.2	190,000
90	7.2	134,000	17.1	213,750
100	8.0	160,000	19.0	237,500

- from manufacturer's literature

ECO-9 HEAT RECLAIM FROM HOT REFRIGERANT GAS

A heat exchanger called a desuperheater will produce about MBtu of heat per ton of cooling. The desuperheater will provide hot water up to about 100 °F. Successful ECM requires significant DHW load to use the heat. Trane Co. provided the following costs for desuperheaters and refrigerant piping with installation costs included. Water side piping is not included.

TONS	COST
10	$2000
20	$2800
30	$3700
40	$5000
50	$6000
60	$7500
80	$9800
100	$12,200
120	$15,500
160	$20,000
200	$23,000

TAG ________________

PRINT DATE: 9-1-93	FILE NO: PL-SV-CG-RDHA-SU-001.01	REPLACES: RDHA-SU-001.00	RDHA-SU-001.01

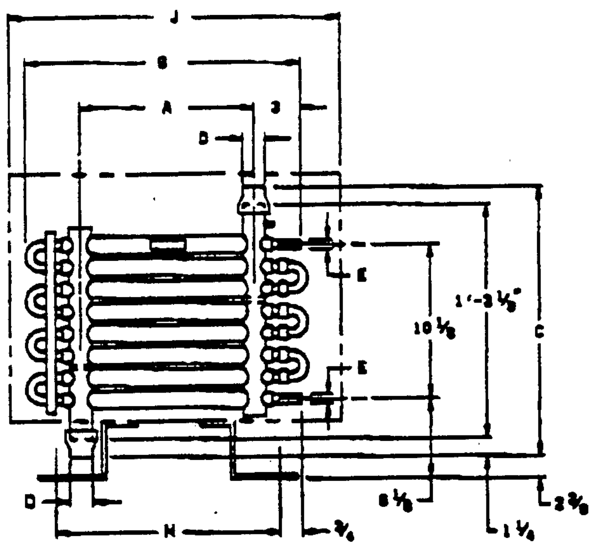
TRANE AIR CONDITIONING

SUBMITTAL

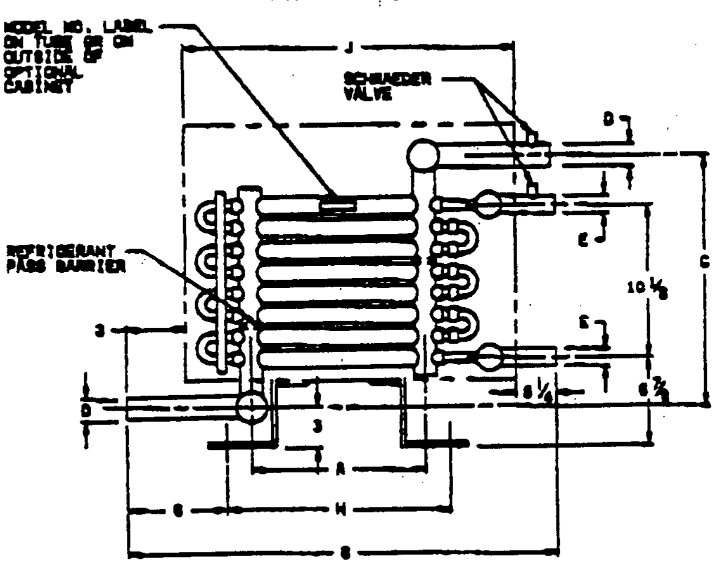
AIR COOLED RECIPROCATING UNITS
DESUPERHEATER / WATER HEATER
RDHA 10 THRU 100 TONS

(RDHA-S-1)

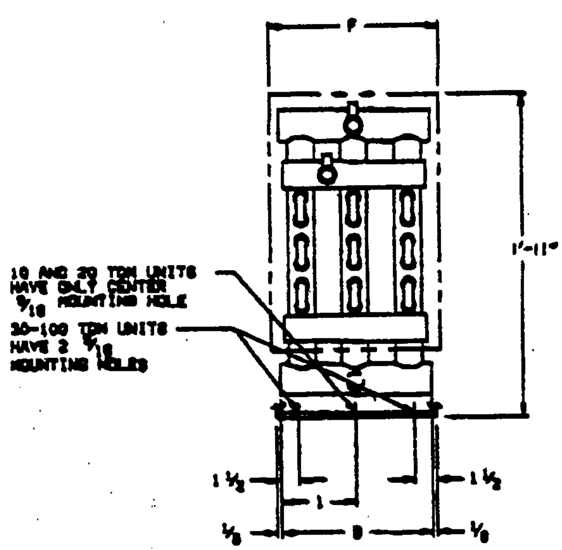
UNIT SIZE	NO OF SECTIONS	A	B	C	REFRIG ID D	WATER OD E	F	G	H	J	EST UNIT WEIGHT (LBS)	EST UNIT WEIGHT WITH CABINET (LBS)
10	1	3'-8"	2	1'-5 1/2"	1 1/8	5/8	2 3/4	4'-2"	4'-0 5/8"	4'-6 5/8"	84	95
10-0S		4'-8"						5'-0"	4'-10 5/8"	5'-4 5/8"	77	114
20	2	3'-8"	4	1'-5 3/4"	1 1/8	7/8	4 3/4	6'-2 7/8"	4'-0 5/8"	4'-6 5/8"	115	148
20-0S		4'-8"						6'-0 7/8"	4'-10 5/8"	5'-4 5/8"	137	177
30	3	3'-8"	6	1'-5 3/4"	1 3/8	1 1/8	6 3/4	6'-2 7/8"	4'-0 5/8"	4'-6 5/8"	181	197
30-0S		4'-8"						6'-0 7/8"	4'-10 5/8"	5'-4 5/8"	185	236
40	4	3'-8"	8	1'-5 3/4"	1 5/8	1 3/8	8 3/4	6'-2 7/8"	4'-0 5/8"	4'-6 5/8"	212	252
40-0S		4'-8"						6'-0 7/8"	4'-10 5/8"	5'-4 5/8"	253	290
50	5	3'-8"	10	1'-5 3/4"	1 5/8	1 3/8	10 3/4	6'-2 7/8"	4'-0 5/8"	4'-6 5/8"	260	303
50-0S		4'-8"						6'-0 7/8"	4'-10 5/8"	5'-4 5/8"	310	358
60	6	3'-8"	1'-0"	1'-5 3/4"	2 1/8	1 5/8	1'-0 3/4"	6'-2 7/8"	4'-0 5/8"	4'-6 5/8"	311	357
60-0S		4'-8"						6'-0 7/8"	4'-10 5/8"	5'-4 5/8"	388	422
80	8	3'-8"	1'-4"	1'-5 3/4"	2 1/8	2 1/8	1'-4 3/4"	6'-2 7/8"	4'-0 5/8"	4'-6 5/8"	411	482
80-0S		4'-8"						6'-0 7/8"	4'-10 5/8"	5'-4 5/8"	487	547
100	10	3'-8"	1'-8"	1'-5 3/4"	2 5/8	2 1/8	1'-8 3/4"	6'-2 7/8"	4'-0 5/8"	4'-6 5/8"	508	585
100-0S		4'-8"						6'-0 7/8"	4'-10 5/8"	5'-4 5/8"	602	668



10 TON UNIT
FRONT VIEW

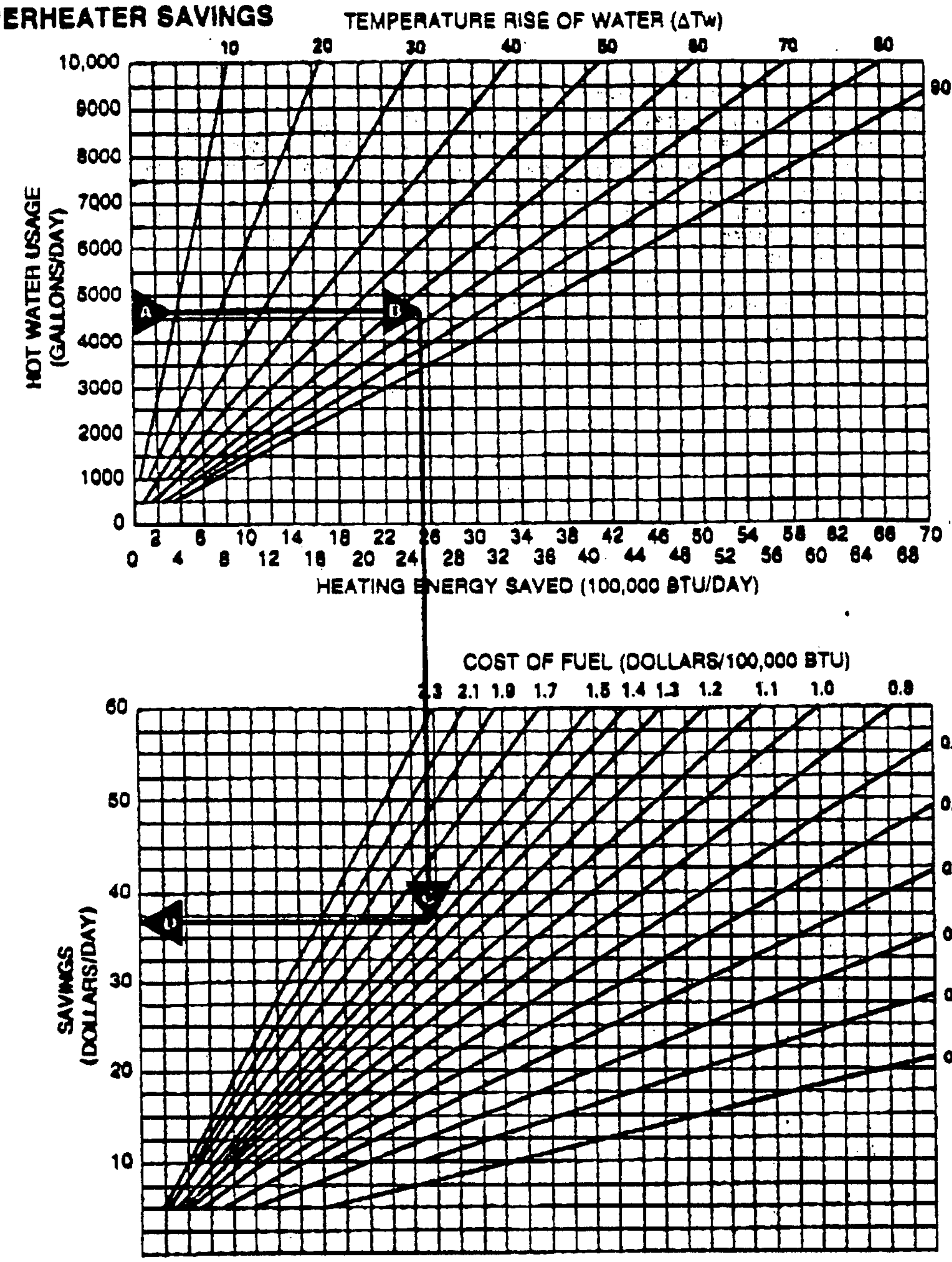


20-100 TON UNITS
FRONT VIEW



END VIEW
(30 TON UNIT SHOWN)

ANNUAL DESUPERHEATER SAVINGS



EXAMPLE:

1. A 40-ton unit operating at full capacity can generate 192 gallons of hot water per hour when heated from 75 F to 140 F. This is equal to 4,608 gallons per day. Locate 4,608 gallons per day on the nomograph (point A).
2. The ΔT_w is 140 F − 75 F = 65 F. Follow the horizontal line at 4,608 gallons per day across to 65 F T_w (point B).
3. Drop vertically to the lower section of the nomograph to the cost per 100,000 Btu. In this case let's use an electric water heater at $0.05 per kwh to yield a cost of $1.47 per 100,000 Btu (point C).
4. Run horizontally to the left to $37/day savings (point D).
5. If this air conditioning unit operated at full capacity for 120 days per year, the desuperheater would provide the following yearly savings:

$$\frac{\$37}{\text{day}} \times 120 \text{ operating days/year} = \frac{\$4,440}{\text{year}}$$

Depending on the installation, this savings could result in a payback period as low as one year!

UP TO 12% HIGHER OPERATING EFFICIENCIES

But the energy savings derived from Trane desuperheaters continue beyond 'free' hot water. Desuperheaters also deliver increased unit efficiency.

Desuperheaters remove heat from the discharge gas before it reaches the condenser coil. This allows the condenser to work more efficiently and, in turn, allows your air conditioner to provide more cooling with the same amount of energy or less. Increasing your total unit operating efficiency by up to 12 percent!

APPENDIX C-10

PREVENT AIR STRATIFICATION

PREVENT AIR STRATIFICATION, ECO #10
BUILDING 366

Given:

Gas Savings Factor	= 0.00342 MBtu / ft^2	- from Bldg 207 simulation
Electric Savings Factor	= -0.42832 Kwh / ft^2	- from Bldg 207 simulation
Demand Savings Factor	= 0.0 kW	- from Bldg 207 simulation
Gas Cost	= $4.67 / MBtu	- from utility rate analysis
Electric Cost	= $0.0255 / kWh	- from utility rate analysis
Demand Cost	= $8.85 / kW	- from utility rate analysis

Peak Demand Savings:

(3127 ft^2)*(0.0 kW / UA) = 0.0 kW

Annual Energy Savings:

- Gas:	(3,127 ft^2)*(0.00342 MBtu / ft^2)	= 11 MBtu
- Electric:	(3,127 ft^2)*(-0.42832 kWh / ft^2)	= -1,339 kWh

Annual Cost Savings:

(11 MBtu)*($4.67 / MBtu) + (-1,339 kWh)*($0.0255 / kWh) + (0.0 kW)*($8.85 / kW)*(4 + .95 * 8) = $17 / yr

Estimated Construction Cost:

$ 194.37 per 1,000 sq. ft. * 3127 sq. ft. = $608
$608 + ($608 + 0.055 SIOH) + ($608 * 0.06 DESIGN) = $678

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: PREVENT AIR STRATIFICATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 07/20/92
FILE: DESTRAT.WK3
PRPARED BY: DENNIS JONES
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR	SAVINGS FACTOR
INCREMENTAL GAS COST	$4.67 MBtu	14.45 UPWG	0.00352 MBtu/ft2
INCREMENTAL ELECTRIC COST	$0.0256 kWh	11.11 UPWE	−0.42821 kWh/ft2
ELECTRIC DEMAND CHARGE	$102.66 kW	10.59 UPW	0.00000 kW/ft2
ECONOMIC LIFE	15 YRS		

BUILDING NUMBER	FLOOR AREA (ft2)	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWH)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND SAVINGS ($)	ANNUAL NON-ENE SAVINGS ($)	TOTAL ANNUAL SAVINGS ($)	CONST. COST ($)	SIR	SIMPLE PAYBACK (YRS)
366	3127	0	(1,339)	11	6	17	0	0	17	678	0.5	39.7

JOB	Ft. McPherson / Ft. Gillem ESOS Study		
SHEET NO.	EMC # 3105.000	OF	
CALCULATED BY		DATE	
CHECKED BY		DATE	
SCALE			

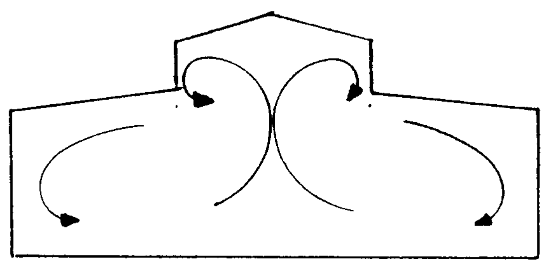
E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • West Germany

DESTRATIFICATION FANS

MFG DATA: 41,000 CFM fan for 5000 ft², 20 feet high ceiling

$$\frac{41{,}000\ ft^3\ 60\ MIN}{(5000\ ft^2 * 20\ ft)\ hr\ min} = 24.6\ ACH$$



Floor area	149,600 ft²
Volume (22 ft ceiling)	3,291,200 ft³
Measured Stratification	3°F @ 40°F outside air temp.

Increasing air changes to 25 ACH will likely result in 1°F of stratification.

$$\frac{25\ ACH * 3{,}291{,}200ft^3}{60\ min\ per\ hr} = 1{,}371{,}333\ cfm$$

OPTION 1:

Green Heck Ventilation unit is 40,000 cfm.

$$\frac{1{,}371{,}333\ cfm}{40{,}000} = 34\ units$$

Each unit has a 10 hp Green Heck motor. 10 hp * 0.746 kW * .85/.865 = 7.3 kW

34 units * 7.3 kW = 248 total kW

OPTION 2:

A 60" industrial ceiling fan has 41,000 cfm and costs considerably less.

$$\frac{1{,}371{,}333\ cfm}{41{,}000} = 33\ units$$

Each unit has a 145 watt motor.

$$\frac{145\ watts * 33\ units * 1kW}{1000\ watts} = 4.78\ total\ kW$$

DESTRATIFICATION FANS, COST ESTIMATE

COSTS

1 fan per 5000 ft^2 @ \$170 and 5 man hours per fan.

A total of 75 fans (15 per section) are needed.

Electrical use, 145 watts per 5000 ft^2 = 0.03 W/ft^2.

\$.08/ft^2 for wire and conduit.

FAN	\$34 + 1 man hour per 1000 ft^2
POWER	\$80 per 1000 ft^2
LABOR	\$60 per 1000 ft^2
MATERIALS	\$20 per 1000 ft^2

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study
LOCATION Ft. McPherson & Ft Gillem

INVITATION NO./CONTRACT NO.
DACA 21-91-C-0097
X CODE A   CODE B   CODE C
OTHER

EFFECTIVE PRICING DATE APR 92
DRAWING NO.
ESTIMATOR RMG

DATE PREPARED 22-Apr-92
SHT OF
CHECKED BY CEL

	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
ECO-10 TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
DESTRATIFICATION FANS													
CEILING FANS	1	MSF	1	1	$20.88	$20.88			$34.00	$34.00	$54.88		
ELECTRIC SERVICE	1	MSF	3	2.85	$21.17	$60.33			$20.00	$20.00	$80.33		
SUBTOTAL						$81.21				$54.00	$135.21		
OVERHEAD, BOND	15%					$12.18				$8.10	$20.28		
PROFIT	10%					$8.12				$5.40	$13.52		
COST SUB-TOTAL						$101.52				$67.50	$169.02		
CONTINGENCY	15%					$15.23				$10.13	$25.35		
TOTAL						$116.75				$77.63	$194.37		

DA FORM 5418-R, APR 85

APPENDIX C-11

REPLACE STREET LIGHTS

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: MECO25
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-11 REPLACE STREET LIGHTS
ANALYSIS DATE: 09-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	6204.
B. SIOH	$	342.
C. DESIGN COST	$	373.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	6919.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	148.	$ 1106.	15.61	17260.
B. DIST	$ .00	0.	$ 0.	21.66	0.
C. RESID	$ .00	0.	$ 0.	26.51	0.
D. NAT G	$ 4.67	0.	$ 0.	23.77	0.
E. COAL	$ .00	0.	$ 0.	16.06	0.
F. TOTAL		148.	$ 1106.		$ 17260.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 417.
(1) DISCOUNT FACTOR (TABLE A) 14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 6063.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 6063.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 5696.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) 3.32
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 1523.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 23323.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 3.37
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 4.54

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO-11: REPLACE EXTERIOR LIGHTING

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 09/01/92
FILE: EXT_LITES.WK3
PRPARED BY: JIM WATTERS
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
INCREMENTAL GAS COST	$4.67 MBtu	23.77 UPWG
INCREMENTAL ELECTRIC COST	$0.0256 kWh	15.61 UPWE
ELECTRIC DEMAND CHARGE	$102.66 kW	14.53 UPW
ECONOMIC LIFE	25 YRS	
ESTIMATED 3285 HOURS OF EXTERIOR LIGHTING PER YEAR		

Existing Bulb Wattage (WATTS)	Existing Bulb Type	Number of Bulbs	Replacement Bulb Wattage (WATTS)	Replacement Bulb Type	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWH)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND SAVINGS ($)	ANNUAL NON-ENERGY SAVINGS ($)	TOTAL ANNUAL SAVINGS ($)	CONST. COST ($)	SIR	SIMPLE PAYBACK (YRS)
1500	QUARTS	12	400	HPS*	0	43,362	0	148	$1,110	$0	$417	$1,527	$6,917	3.4	4.5
TOTAL		12	400	HPS*	0	43,362	0	148	$1,110	$0	$417	$1,527	$6,917	3.4	4.5
500	QUARTS	0	200	HPS*	0	0	0	0	$0	$0	$0	$0	$0		
400	MERCURY	6	360	HPS	0	788	0	3	$20	$0	$0	$20	$529	0.6	26.2
175	MERCURY	24	150	HPS	0	1,971	0	7	$50	$0	$0	$50	$1,793	0.4	35.5

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

[X] CODE A [ ] CODE B [ ] CODE C [ ] OTHER ______

EFFECTIVE PRICING DATE APR 92

DATE PREPARED 22-Apr-92

DRAWING NO.

SHT OF

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

ESTIMATOR RMG

CHECKED BY CEL

EXTERIOR LIGHTING	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
400 W HPS LAMP w/ FIXTURE	1	EA	4	4	$21.17	$84.68			$275.00	$275.00	$359.68		
OVERHEAD, BOND	15%					$12.70				$41.25	$53.95		
PROFIT	10%					$8.47				$27.50	$35.97		
COST SUB-TOTAL						$105.85				$343.75	$449.60		
CONTINGENCY	15%					$15.88				$51.56	$67.44		
TOTAL						$121.73				$395.31	$517.04		
200 W HPS LAMP w/ FIXTURE	1	EA	4	4	$21.17	$84.68			$250.00	$250.00	$334.68		
OVERHEAD, BOND	15%					$12.70				$37.50	$50.20		
PROFIT	10%					$8.47				$25.00	$33.47		
COST SUB-TOTAL						$105.85				$312.50	$418.35		
CONTINGENCY	15%					$15.88				$46.88	$62.75		
TOTAL						$121.73				$359.38	$481.10		
360 W HPS LAMP	1	EA	1	1	$21.17	$21.17			35	$35.00	$56.17		
OVERHEAD, BOND	15%					$3.18				$5.25	$8.43		
PROFIT	10%					$2.12				$3.50	$5.62		
COST SUB-TOTAL						$26.46				$43.75	$70.21		
CONTINGENCY	15%					$3.97				$6.56	$10.53		
TOTAL						$30.43				$50.31	$80.74		
150 W HPS LAMP	1	EA	1	1	$21.17	$21.17			25	$25.00	$46.17		
OVERHEAD, BOND	15%					$3.18				$3.75	$6.93		
PROFIT	10%					$2.12				$2.50	$4.62		
COST SUB-TOTAL						$26.46				$31.25	$57.71		
CONTINGENCY	15%					$3.97				$4.69	$8.66		
TOTAL						$30.43				$35.94	$66.37		

DA FORM 5418-R, APR 85

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • Germany

JOB Ft. McPherson /Gillem
EMC # 3105.000

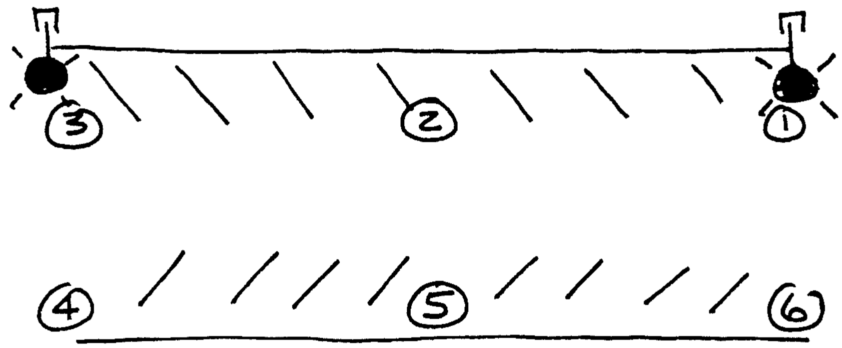
SHEET NO. ______ OF ______

CALCULATED BY CRL DATE 7/21/92

CHECKED BY ______ DATE ______

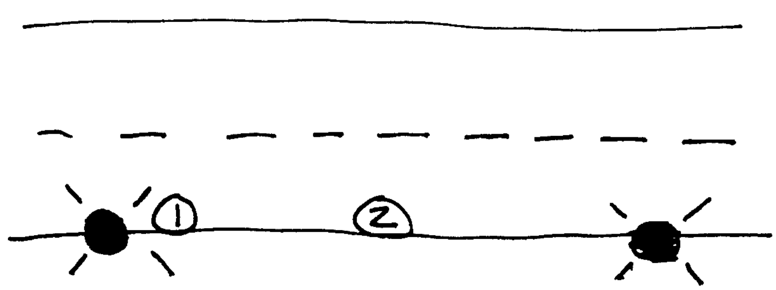
SCALE ______

STREET LIGHT READINGS
PARKING LOT BEHIND B. 200



① — 2.07 FOOTCANDLES
② — 0.35 "
③ — 2.10 "
④ — 0.37 "
⑤ — 0.10 "
⑥ — 0.35 "

STREET BEHIND PX



① 3.7 FOOTCANDLES
② 1.2 "

JOB FT. McPAERSON / GILLEM
EMC# 3105.000

SHEET NO. ____ OF ____

E M C ENGINEERS, INC.

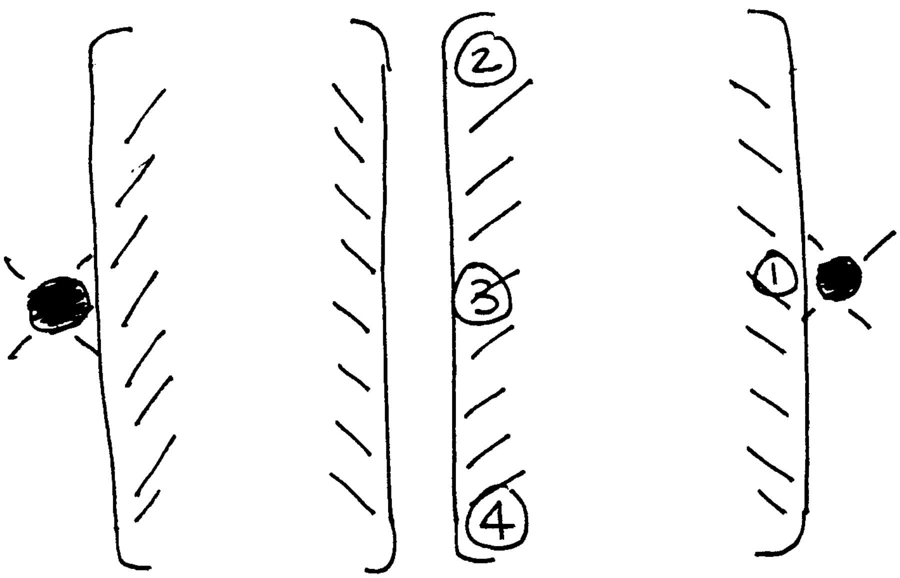
Denver • Colorado Springs • Atlanta • Germany

CALCULATED BY CEL DATE 7/21/92

CHECKED BY ____ DATE ____

SCALE ____

STREET LIGHT READINGS
PARKING LOT IN FRONT OF B 200



1	—	2.07	FOOTCANDLES
2	—	0.17	"
3	—	0.33	"
4	—	0.03	"

CROSS WALK IN FRONT OF BLDG 200
0.80 FOOTCANDLES

JOB FT. McPHERSON / GILLEM
EMC # 3105,000

SHEET NO. ______ OF ______

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • Germany

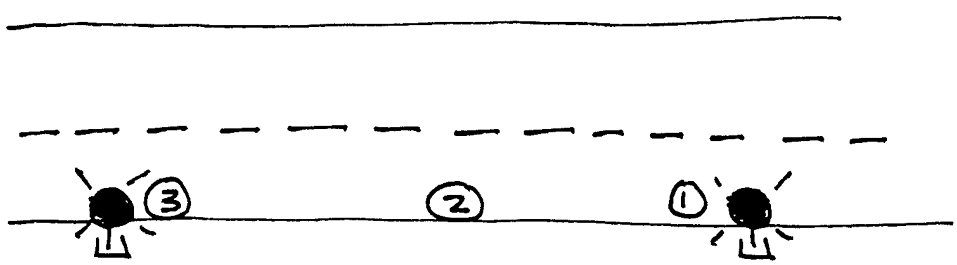
CALCULATED BY CEL DATE 7/21/92

CHECKED BY ______ DATE ______

SCALE ______

STREET LIGHT READINGS

STREET IN FRONT OF B, 200

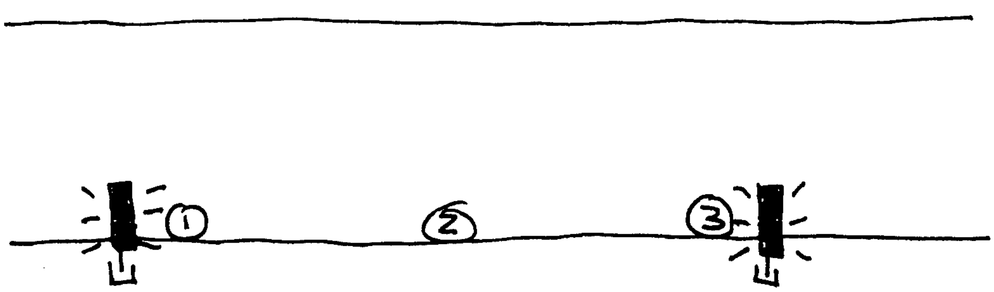


1 — 3.4 FOOTCANDLES

2 — 0.13 "

3 — 3.4 "

STREET IN FRONT OF B, 168



1 — 0.17 FOOTCANDLES

2 — 0.09 "

3 — 0.18 "

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • Germany

JOB FT. McPHERSON / GILLEM
EMC # 3105.000

SHEET NO. ______ OF ______

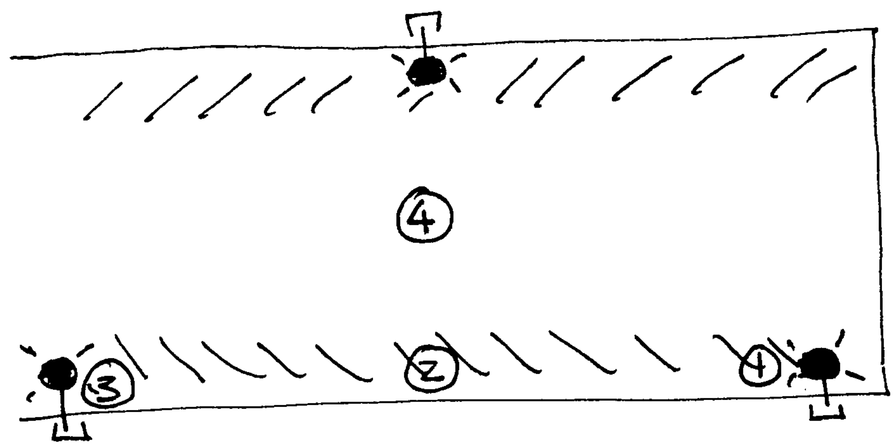
CALCULATED BY CEL DATE 7/21/92

CHECKED BY ______ DATE ______

SCALE ______

STREET LIGHT READINGS

BLDG PARKING LOT



① — 2.47 FOOTCANDLES
② — 0.23 "
③ — 2.33 "
④ — 0.64 "

Fig. 14-18. Recommended Maintained Illuminances for Open and Covered Parking Facilities

Open Parking Facilities								
Level of Activity	For Vehicular Traffic			For Pedestrian Safety		For Pedestrian Security		
	Lux*	Footcandles*	Uniformity Ratio	Lux**	Footcandles**	Lux*	Footcandles*	Uniformity Ratio
Low activity	5	0.5	4:1	2	0.2	9	0.8	5:1
Medium activity	11	1	3:1	6	0.6	22	2	5:1
High activity	22	2	3:1	10	0.9	43	4	5:1

Covered Parking Facilities				
Areas	Day		Night	
	Lux***	Footcandles***	Lux*	Footcandles*
General parking and pedestrian areas	54	5	54	5
Ramps and corners	110	10	54	5
Entrance areas	540	50	54	5
Stairways and lobbys (refer to Fig. 2-2)				

* Average on pavement
** Minimum on pavement
*** Average on payment—sum of electric lighting and daylight

the "High" activity lighting levels may be required, but while the game is being played or during hours of reduced activity the "Medium" or "Low" activity lighting levels may be adequate.

ROADWAY ILLUMINATION DATA AND CALCULATIONS

The following is an example of a simple and straightforward calculation procedure to determine average illuminance and illuminance at a specific point on a roadway. For a detailed treatment of the subject, including calculations for high-mast and pedestrian walkway lighting, the reader is referred to Reference 1.

Determination of Average Illuminance

The average illuminance over a large pavement area in terms of lux (footcandles) may be calculated by means of a "utilization curve" of the type shown in Fig. 14-19.

Utilization Curves. Utilization curves, available for various types of luminaires, afford a practical method for the determination of average illuminance over the roadway surface where lamp size, mounting heights, width of roadway, overhang and spacing between luminaires are known or assumed. Conversely, the desired spacing or any other unknown factor may readily be determined if the other factors are given.

The Coefficient of Utilization, as shown in Fig. 14-19, is the percentage of rated lamp lumens which will fall on either of two strip-like areas of infinite length, one extending in front of the luminaire (street side), and the other behind the luminaire (house side), when the luminaire is level and oriented over the roadway in a manner equivalent to that in which it was tested. Since roadway width is expressed in terms of a ratio of luminaire mounting height to roadway width, the term has no dimensions.

Light Loss Factors. There are a number of causes of light loss. They are listed on page 4-21. For each cause, a factor can be determined. All individual factors can be multiplied together to obtain one total light loss factor. Some factors, usually due to less than ideal operating conditions, exist initially and continue through the life of the installation. They may, however, have too little effect to justify correction or be too costly to correct. The significant light loss factors in roadway calculations are:

Lamp Lumen Depreciation. Information about lamp lumen depreciation is available from manufacturers' tables and graphs for lumen depreciation and mortality of the chosen lamp. Rated average life should be determined for the specific hours per start; it should be known when burnouts will begin in the lamp life cycle. From these facts, a practical group relamping cycle will be established and then, based on the hours elapsed to lamp removal, the specific lamp lumen depreciation (LLD) factor can be determined.

APPENDIX C-12

REVISE OR REPAIR HVAC CONTROLS

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: MECO15
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-12 HVAC CONTROLS
ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	245113.
B. SIOH	$	13482.
C. DESIGN COST	$	14707.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	273302.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	4712.	$ 35207.	11.11	391147.
B. DIST	$ .00	0.	$ 0.	14.26	0.
C. RESID	$ .00	0.	$ 0.	16.89	0.
D. NAT G	$ 4.67	1386.	$ 6473.	14.45	93529.
E. COAL	$ .00	0.	$ 0.	11.21	0.
F. TOTAL		6098.	$ 41679.		$ 484676.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 10648.
(1) DISCOUNT FACTOR (TABLE A) 10.59
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 112762.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 112762.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 159943.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 52327.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 597438.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 2.19
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 5.22

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 12 – HVAC Controls

CLIENT CONTRACT NO: DACA21–91–C–0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 16–Jul–92
FILE: ECO–12.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	14.45 UPWG
Electric Savings	$0.0255 / kWh	11.11 UPWE
Demand Savings	$8.85 / kW	10.59 UPW

Economic Life: 15 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON–ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
171	26	193,390	262	921	$6,155	$2,669	$127	$8,951	$24,886	4.1	2.8
170	23	171,230	232	816	$5,450	$2,363	$127	$7,940	$28,402	3.2	3.6
131	22	160,374	217	764	$5,104	$2,213	$127	$7,445	$31,919	2.7	4.3
181	0	249,984	202	1,054	$7,318	$0	$127	$7,445	$41,867	2.0	5.6
246	0	181,411	42	661	$4,822	$0	$127	$4,949	$27,815	2.0	5.6
500	4	173,997	413	1,006	$6,366	$411	$127	$6,903	$45,699	1.8	6.6
101	8	113,894	0.29	389	$2,906	$822	$127	$3,855	$24,599	1.7	6.4
514	5	65,286	17	240	$1,744	$513	$127	$2,384	$23,514	1.1	9.9
100	5	71,096	0.18	243	$1,814	$513	$127	$2,454	$24,599	1.1	10.0
TOTAL	93	1,380,662	1,386	6,094	$41,678	$9,505	$1,143	$52,327	$273,301	2.2	5.2
184	1	116,277	120	517	$3,525	$103	$127	$3,755	$52,733	0.8	14.0
358	15	40,348	7	144	$1,061	$1,540	$127	$2,728	$38,666	0.8	14.2
168	2	31,210	19	125	$885	$205	$127	$1,217	$24,886	0.5	20.4
060	5	15,696	84	138	$793	$513	$127	$1,433	$61,950	0.3	43.2
062	4	12,093	65	106	$611	$395	$127	$1,133	$47,883	0.3	42.3
056	4	11,756	63	103	$594	$384	$127	$1,105	$47,883	0.3	43.3
058	4	11,967	64	105	$604	$391	$127	$1,123	$47,883	0.3	42.7
200	0	(3,423)	0	(12)	($87)	$0	$0	($87)	No Savings		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 12 – HVAC Controls

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

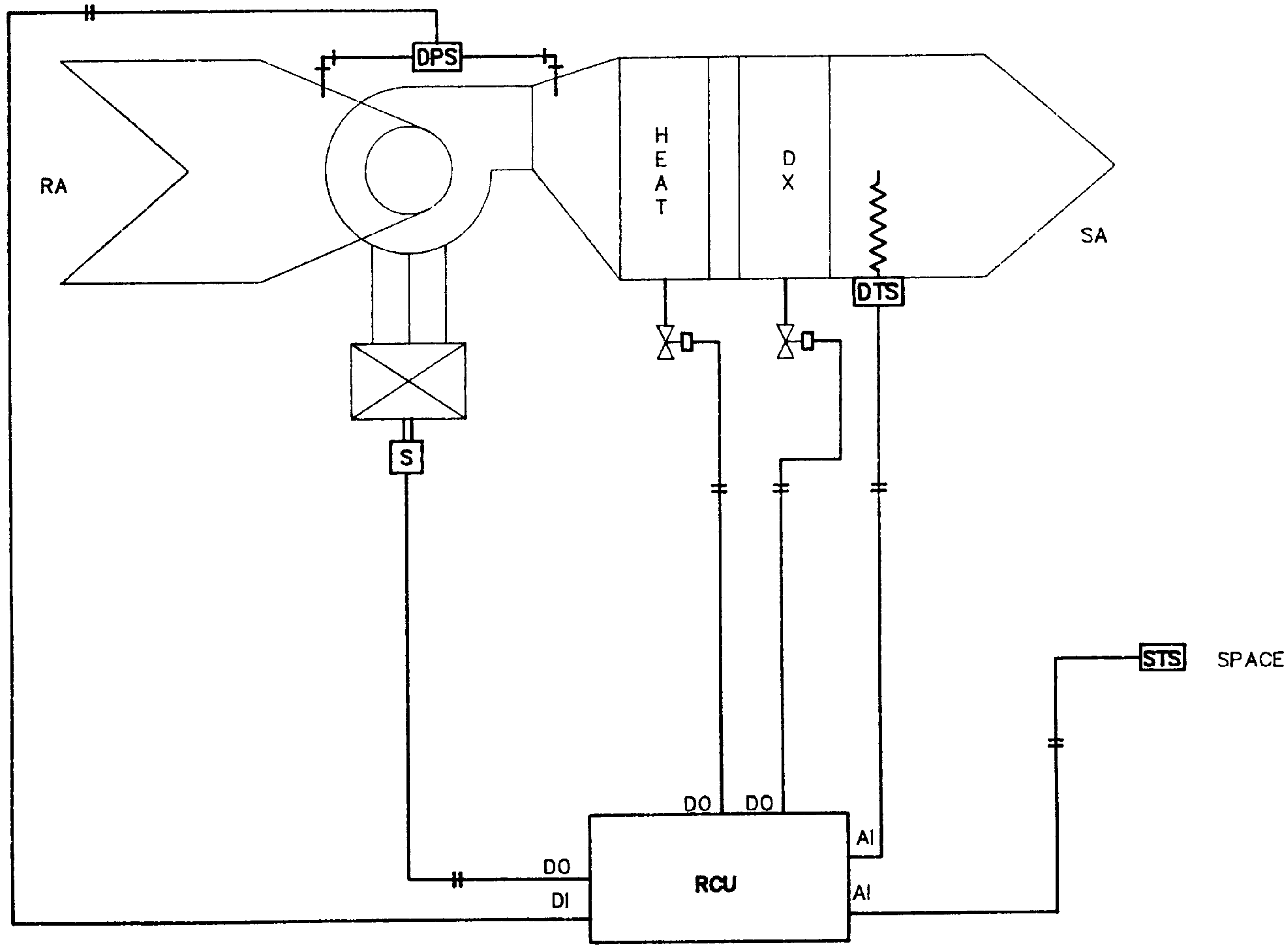
EMC PROJECT: #3105.000
DATE:
FILE: ECO-12.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG #	EQUIPMENT	#	UNIT COST ($/ea)	SUB-TOTAL ($)	TOTAL COST ($)
060				$55,560	$61,950
	DDC Panel	1	$8,050.00		
	FCU	12	$3,154.00		
	Chiller	0.25	$3,577.00		
	Conv	2	$4,384.00		
056,058,				$42,944	$47,883
062	DDC Panel	1	$8,050.00		
	FCU	8	$3,154.00		
	Chiller	0.25	$3,577.00		
	Conv	2	$4,384.00		
100,101				$22,062	$24,599
	DDC Panel	1	$8,050.00		
	AHU	2	$3,154.00		
	Chiller	1	$3,577.00		
	Boiler	1	$4,127.00		
131				$28,627	$31,919
	DDC Panel	1	$8,050.00		
	AHU	4	$3,154.00		
	Chiller	1	$3,577.00		
	Conv	1	$4,384.00		
168				$22,319	$24,886
	DDC Panel	1	$8,050.00		
	FCU	2	$3,154.00		
	Chiller	1	$3,577.00		
	Conv	1	$4,384.00		
170				$25,473	$28,402
	DDC Panel	1	$8,050.00		
	AHU	3	$3,154.00		
	Chiller	1	$3,577.00		
	Conv	1	$4,384.00		
171				$22,319	$24,886
	DDC Panel	1	$8,050.00		
	AHU	2	$3,154.00		
	Chiller	1	$3,577.00		
	Conv	1	$4,384.00		
181				$37,549	$41,867
	DDC Panel	1	$8,050.00		
	MZ AHU	2	$9,192.00		
	FCU	1	$3,154.00		
	Chiller	1	$3,577.00		
	Conv	1	$4,384.00		
184				$47,294	$52,733
	DDC Panel	1	$8,050.00		
	AHU	10	$3,154.00		
	Chiller	1	$3,577.00		
	Boiler	1	$4,127.00		
246				$24,946	$27,815
	DDC Panel	1	$8,050.00		
	MZ AHU	1	$9,192.00		
	Chiller	1	$3,577.00		
	Boiler	1	$4,127.00		
358				$34,678	$38,666
	DDC Panel	1	$8,050.00		
	AHU	6	$3,154.00		
	Chiller	1	$3,577.00		
	Boiler	1	$4,127.00		
500				$40,986	$45,699
	DDC Panel	1	$8,050.00		
	AHU	8	$3,154.00		
	Chiller	1	$3,577.00		
	Boiler	1	$4,127.00		
514				$21,089	$23,514
	DDC Panel	1	$8,050.00		
	AHU	3	$3,154.00		
	Chiller	1	$3,577.00		

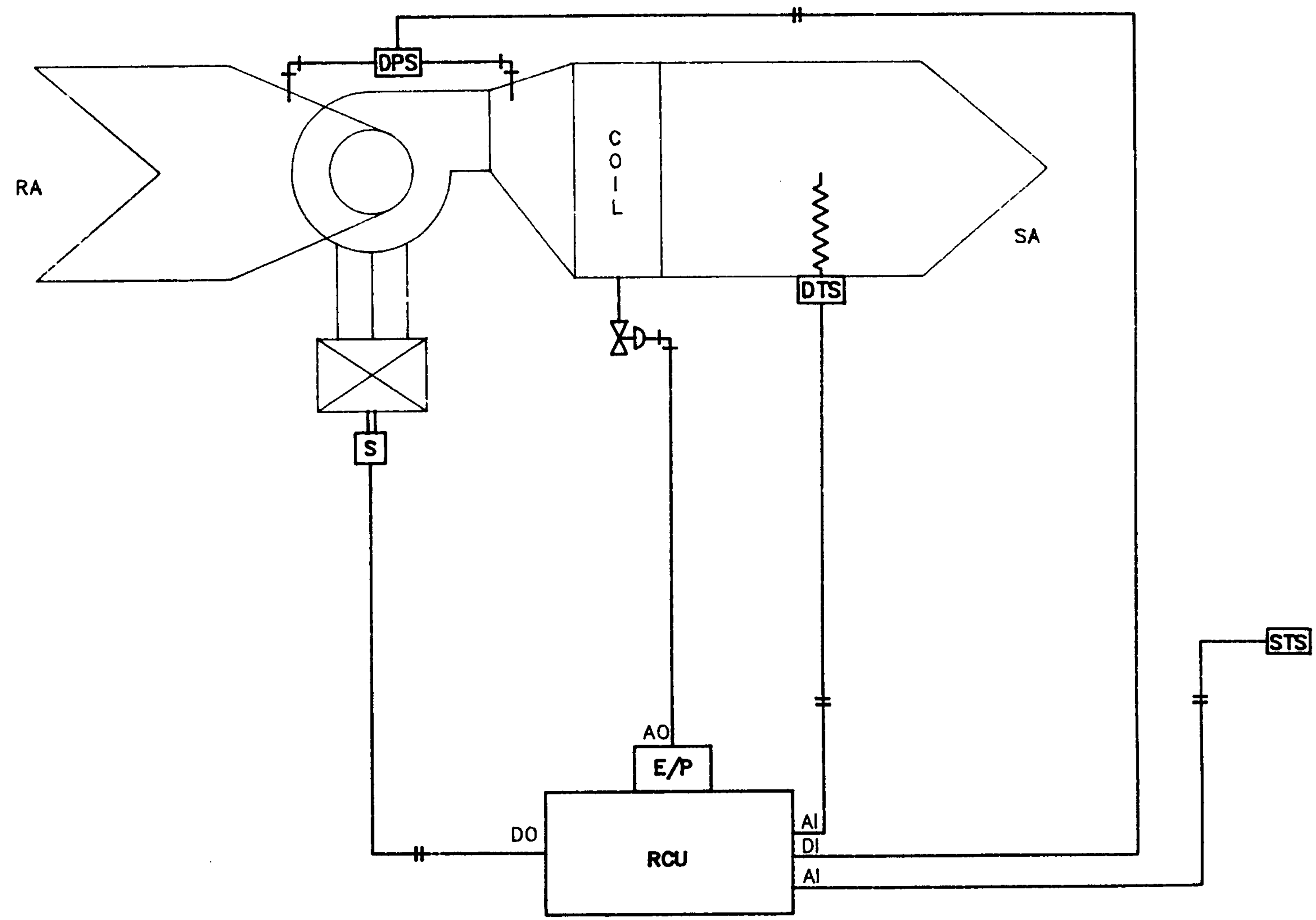
EQUIPMENT COSTS:

DDC Panel	$8,050
FCU	$3,154
AHU	$3,154
MZ AHU	$9,192
Chiller	$3,577
Conv	$4,384
Boiler	$4,127

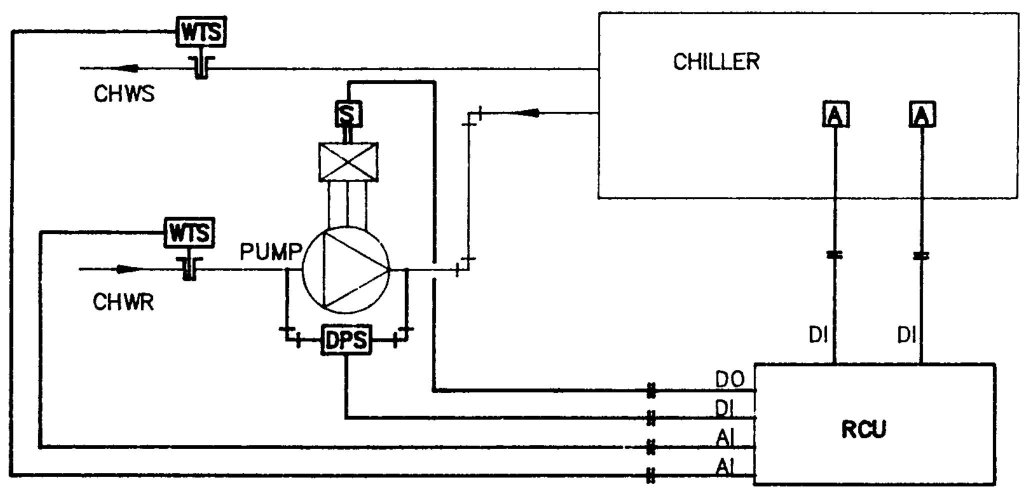
(SUB-TOTAL) + (SUB-TOTAL * .055 SIOH) + (SUB-TOTAL * .06 DESIGN) = TOTAL COST



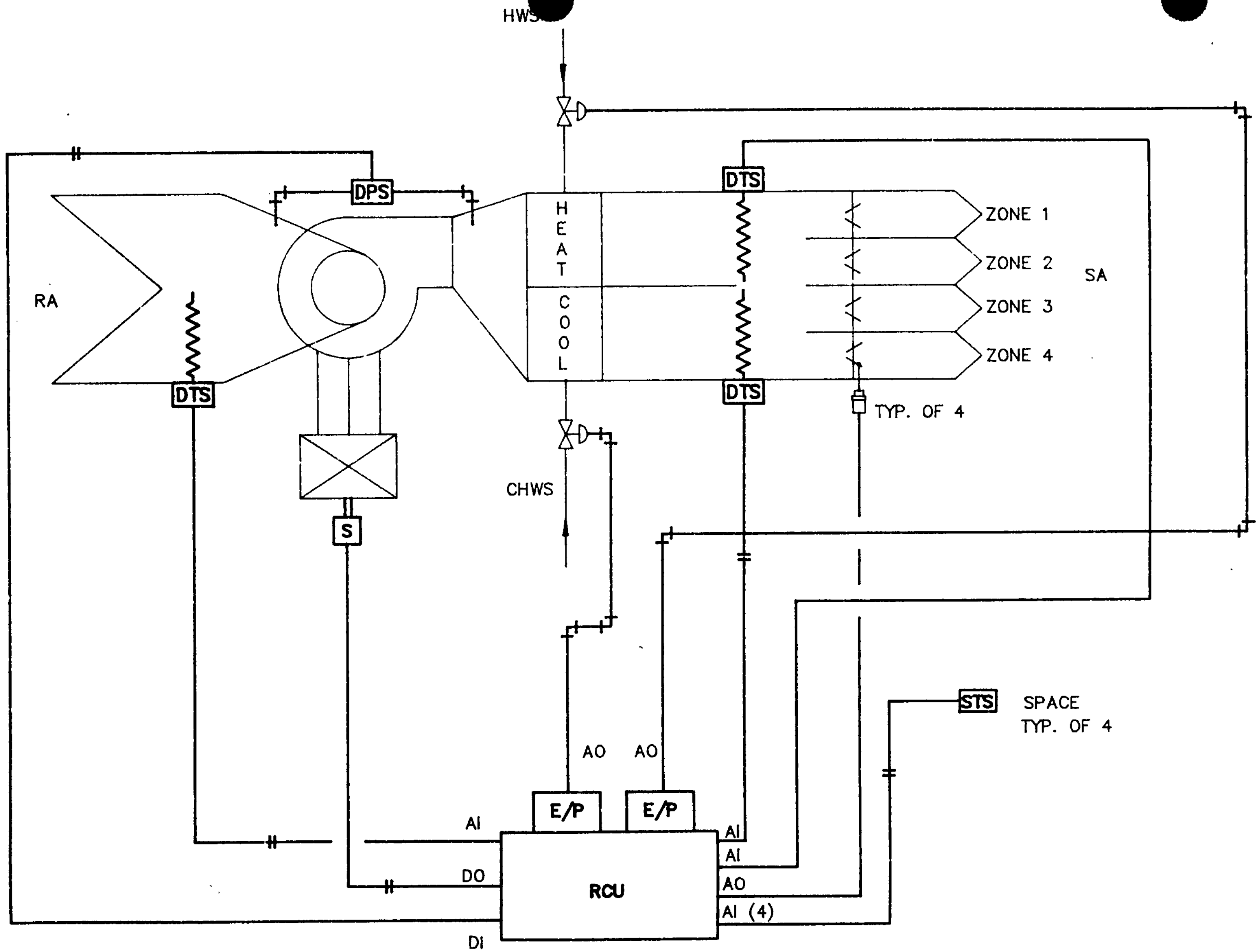
TYPICAL SINGLE ZONE AHU



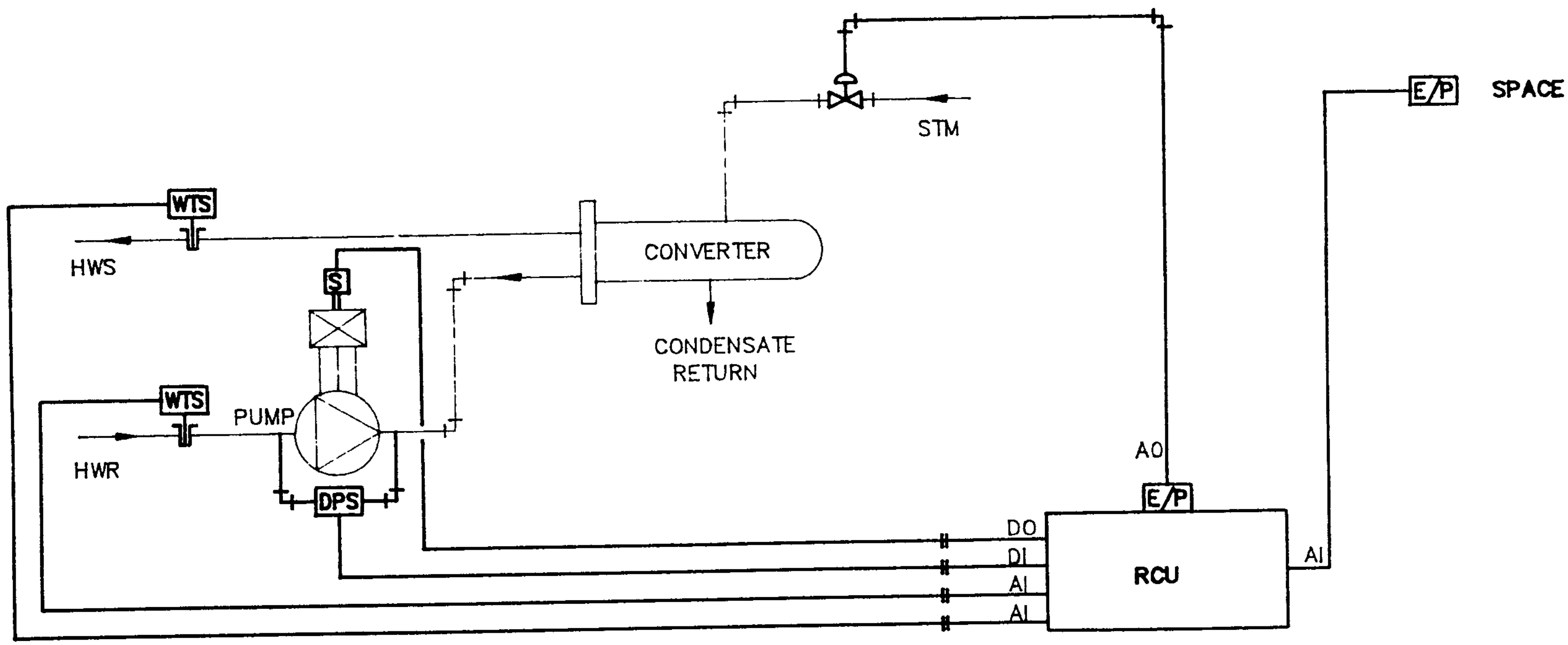
TYPICAL AHU
BLDGS. 184, 60, 56, 58, 62, 100, 101, 358, 500 & 514



TYPICAL AIR COOLED CHILLER
BLDGS. 184, 181, 246, 60, 168, 171, 170, 358 & 500

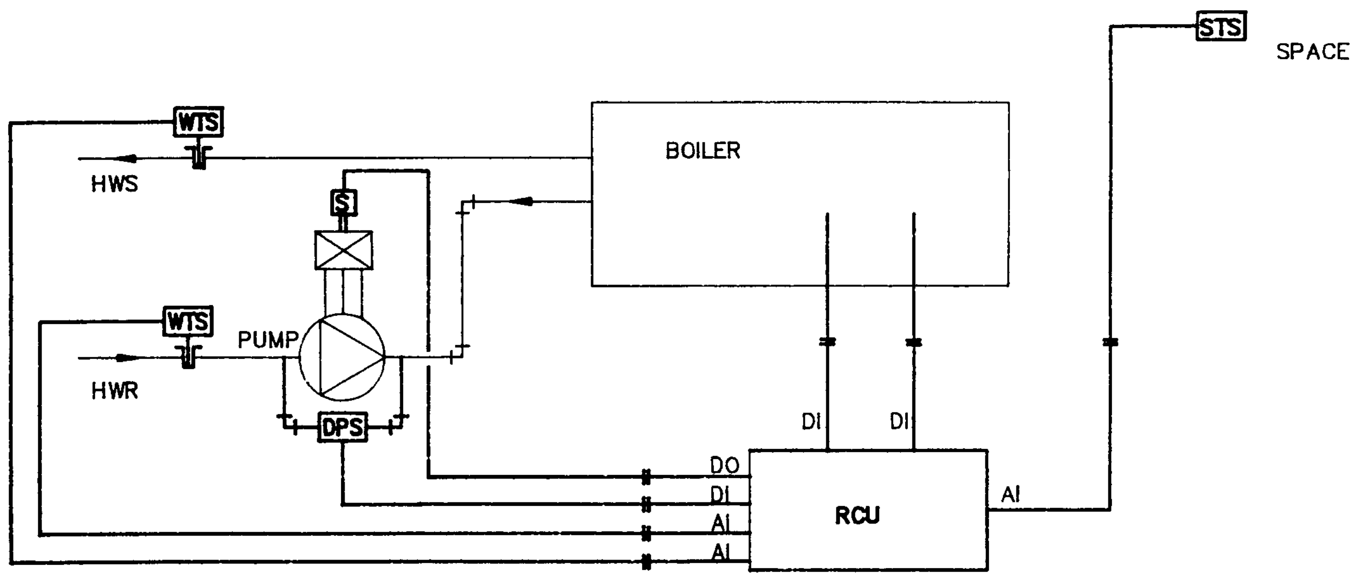


TYPICAL MULTIZONE AHU
BLDGS. 181 & 246

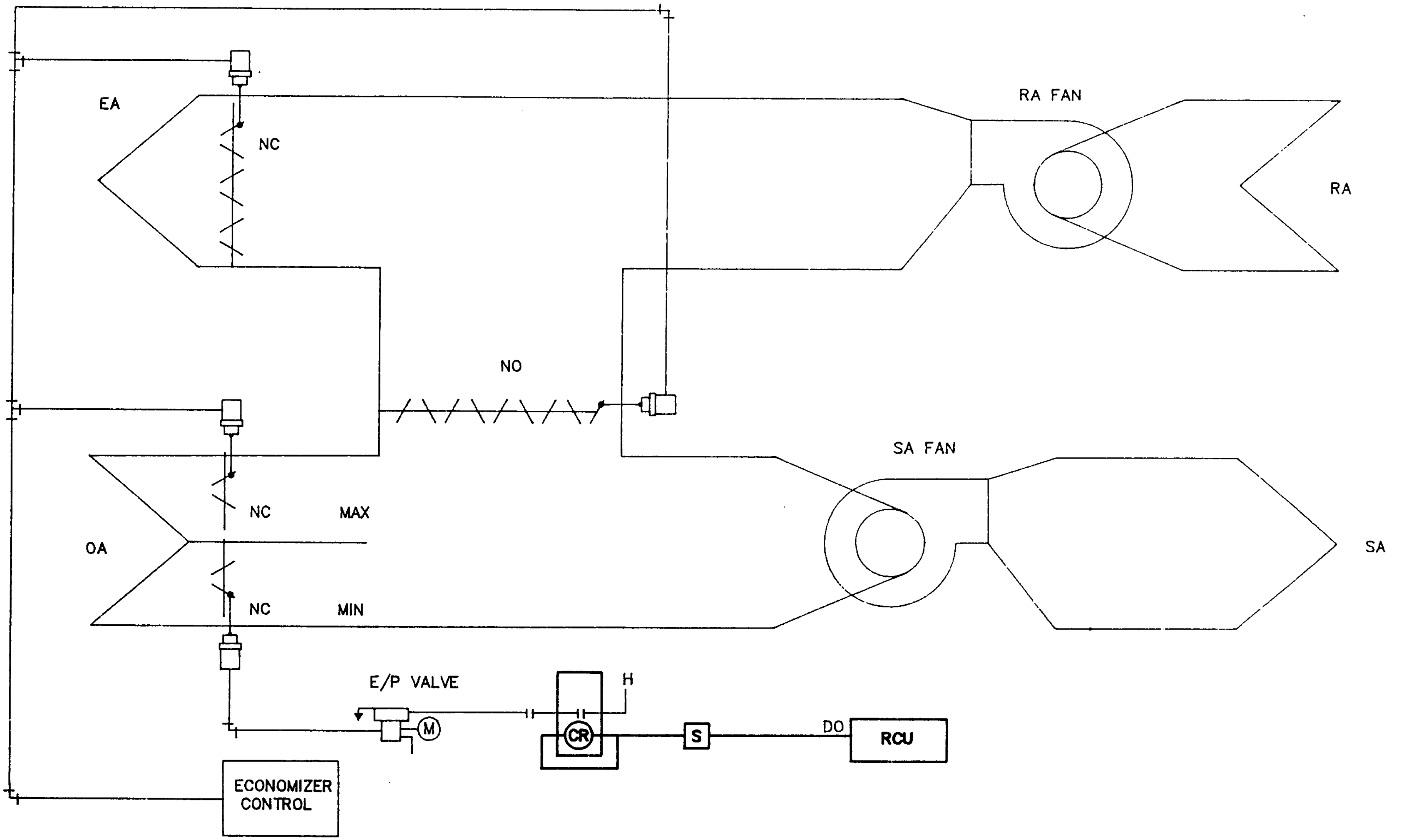


TYPICAL STM/HW CONVERTER

BLDGS. 181, 60, 168, 171, 170, 131, & 61



TYPICAL HW BOILER
BLDGS. 184 & 246



VAV – BUILDING 200

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

X CODE A | CODE B | CODE C | OTHER

EFFECTIVE PRICING DATE APR. 92

DATE PREPARED 16-Apr-92

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

DRAWING NO.

SHT OF

ESTIMATOR RMG

CHECKED BY CEL

CONVERTER	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
WTS	2	EA	5.0	10.0	21.17	$211.70			261.0	522.00	734		
STS	1	EA	1.5	1.5	21.17	$31.76			118	118.00	150		
VALVE	1	EA	2.0	2.0	21.17	$42.34			370	370.00	412		
ST/SP	1	EA	2.0	2.0	21.17	$42.34			66	66.00	108		
PUMP DPS	1	EA	2.5	2.5	21.17	$52.93			129	129.00	182		
WIRE AND CONDUIT	6								$94.00	$564.00	$564.00		
PROGRAMMING	6					$900.00					$900.00		
SUBTOTAL						$1,281				$1,769	$3,050		
CONTINGENCY	15%					$192				$265	$458		
COST SUB-TOTAL						$1,473				$2,034	$3,508		
OVERHEAD, BOND	15%					$221				$305	$526		
PROFIT	10%					$147				$203	$351		
SUBTOTAL						$1,842				$2,543	$4,384		
TOTAL THIS SHEET						$1,842				$2,543	$4,384		

DA FORM 5416-R, APR 85

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

EFFECTIVE PRICING DATE April 92

DATE PREPARED 16-Apr-92

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

X CODE A | CODE B | CODE C | OTHER

DRAWING NO.

SHT OF

ESTIMATOR RMG

CHECKED BY CEL

AHU	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
STS	1	EA	1.5	1.5	21.17	$31.76			$118.00	$118.00	$149.76		
DTS	1	EA	2	2.0	21.17	$42.34			$160.00	$160.00	$202.34		
VALVE	1	EA	2.0	2.0	21.17	$42.34			$370.00	$370.00	$412.34		
ST/SP	1	EA	2.0	2.0	21.17	$42.34			$66.00	$66.00	$108.34		
FAN DPS	1	EA	2.0	2.0	21.17	$42.34			$59.00	$59.00	$101.34		
WIRE AND CONDUIT	5								$94.00	$470.00	$470.00		
PROGRAMMING	5					$750.00					$750.00		
SUBTOTAL						$951				$1,243	$2,194		
CONTINGENCY	15%					$143				$186	$329		
COST SUB-TOTAL						$1,094				$1,429	$2,523		
OVERHEAD, BOND	15%					$164				$214	$378		
PROFIT	10%					$109				$143	$252		
SUBTOTAL						$1,367				$1,787	$3,154		
TOTAL THIS SHEET						$1,367				$1,787	$3,154		

DA FORM 5418-R, APR 85

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study
LOCATION Ft. McPherson & Ft Gillem

INVITATION NO./CONTRACT NO.
DACA 21-91-C-0097
[X] CODE A [ ] CODE B [ ] CODE C
[ ] OTHER

EFFECTIVE PRICING DATE APR. 92
DRAWING NO.
ESTIMATOR RMG

DATE PREPARED 16-Apr-92
SHT OF
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MZ AHU	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
STS	4	EA	1.5	6.0	21.17	85			118	472.00	557		
DTS	3	EA	2.0	6.0	21.17	64			160	480.00	544		
VALVE	2	EA	2.0	4.0	21.17	42			370	740.00	782		
DAMPER	4	EA	1.3	5.2	21.17	85			150	600.00	685		
ST/SP	1	EA	2.0	2.0	21.17	21			66	66.00	87		
FAN DPS	1	EA	2	2.0	21.17	21			59	59.00	80		
WIRE AND CONDUIT	15								$94.00	$1,410.00	$1,410.00		
PROGRAMMING	15					$2,250.00					$2,250.00		
SUBTOTAL						$2,568				$3,827	$6,395		
CONTINGENCY	15%					$385				$574	$959		
COST SUB-TOTAL						$2,953				$4,401	$7,354		
OVERHEAD, BOND	15%					$443				$660	$1,103		
PROFIT	10%					$295				$440	$735		
SUBTOTAL						$3,691				$5,501	$9,192		
TOTAL THIS SHEET						$3,691				$5,501	$9,192		

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

EFFECTIVE PRICING DATE APR. 92

DATE PREPARED 16-Apr-92

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

X CODE A   CODE B   CODE C   OTHER

DRAWING NO.

SHT OF

ESTIMATOR RMG

CHECKED BY CEL

CHILLER	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
WTS	2	EA	5.0	10.0	21.17	42			261	522.00	564		
ST/SP	1	EA	2.0	2.0	21.17	21			66	66.00	87		
PUMP DPS	1	EA	2.5	2.5	21.17	21			129	129.00	150		
STATUS RELAY	2	EA	1.0	2.0	21.17	42			90	180.00	222		
WIRE AND CONDUIT	6								$94.00	$564.00	$564.00		
PROGRAMMING	6					$900.00					$900.00		
SUBTOTAL						$1,027				$1,461	$2,488		
CONTINGENCY	15%					$154				$219	$373		
COST SUB-TOTAL						$1,181				$1,680	$2,861		
OVERHEAD, BOND	15%					$177				$252	$429		
PROFIT	10%					$118				$168	$286		
SUBTOTAL						$1,476				$2,100	$3,577		
TOTAL THIS SHEET						$1,476				$2,100	$3,577		

DA FORM 5416-R, APR 85

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study
LOCATION Ft. McPherson & Ft Gillem

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097
[X] CODE A [ ] CODE B [ ] CODE C
[ ] OTHER

EFFECTIVE PRICING DATE APR. 92
DRAWING NO.
ESTIMATOR RMG

DATE PREPARED 16-Apr-92
SHT OF
CHECKED BY CEL

BOILER	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
WTS	2	EA	5.0	10.0	21.17	42			261	522.00	564		
STS	1	EA	1.5	1.5	21.17	21			118	118.00	139		
ST/SP	1	EA	2.0	2.0	21.17	21			66	66.00	87		
PUMP DPS	1	EA	2.5	2.5	21.17	21			129	129.00	150		
STATUS RELAY	2	EA	1.0	2.0	21.17	42			90	180.00	222		
WIRE AND CONDUIT	7								$94.00	$658.00	$658.00		
PROGRAMMING	7					$1,050.00					$1,050.00		
SUBTOTAL						$1,198				$1,673	$2,871		
CONTINGENCY	15%					$180				$251	$431		
COST SUB-TOTAL						$1,378				$1,924	$3,302		
OVERHEAD, BOND	15%					$207				$289	$495		
PROFIT	10%					$138				$192	$330		
SUBTOTAL						$1,722				$2,405	$4,127		
TOTAL THIS SHEET						$1,722				$2,405	$4,127		

DA FORM 5418-R, APR 85

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO.	DACA 21-91-C-0097
X CODE A / CODE B / CODE C / OTHER	
EFFECTIVE PRICING DATE	APR. 92
DATE PREPARED	16-Apr-92
DRAWING NO.	
SHT OF	
ESTIMATOR	RMG
CHECKED BY	CEL

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

Bldg. 200, VENT. CONTROL	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
ST/SP	1	EA	2.0	2.0	21.17	21			66	66.00	87		
WIRE AND CONDUIT	1								$94.00	$94.00	$94.00		
PROGRAMMING	1					$150.00					$150.00		
SUBTOTAL						$171				$160	$331		
CONTINGENCY	15%					$26				$24	$50		
COST SUB-TOTAL						$197				$184	$381		
OVERHEAD, BOND	15%					$30				$28	$57		
PROFIT	10%					$20				$18	$38		
SUBTOTAL						$246				$230	$476		
TOTAL THIS SHEET						$246				$230	$476		

THE COST SHOWN IS FOR ADDING A START/STOP POINT AND EP VALVE TO SHUT MINIMUM VENTILATION DAMPER ON AHU's CONNECTED TO THE EXISTING EMCS IN BUILDING 200.

DA FORM 5418-R, APR 85

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

[X] CODE A [ ] CODE B [ ] CODE C [ ] OTHER

EFFECTIVE PRICING DATE APR. 92

DATE PREPARED 16-Apr-92

DRAWING NO.

SHT OF

ESTIMATOR RMG

CHECKED BY CEL

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

DDC PANNEL	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
PER BUILDING INCLUDING LABOR, POWER	1								5,600	5600.00	5,600		
CONNECTION, ENCLOSURE													
SUBTOTAL										$5,600	$5,600		
CONTINGENCY	15%									$840	$840		
COST SUB-TOTAL										$6,440	$6,440		
OVERHEAD, BOND	15%									$966	$966		
PROFIT	10%									$644	$644		
SUBTOTAL										$8,050	$8,050		
TOTAL THIS SHEET										$8,050	$8,050		

DA FORM 5416-R, APR 85

E M C ENGINEERS, INC.
Denver • Colorado Springs • Atlanta • Germany

JOB FT. MCPHERSON/GILLEM ESOS STUDY
EMC#3105.000
SHEET NO. ______ OF ______
CALCULATED BY CEL DATE 7/21/92
CHECKED BY ______ DATE ______
SCALE ______

LABOR SAVINGS:

An estimated 6 hours per year labor (non-energy) savings were taken due to a reduction in temperature (too hot-too cold) related services calls.

(6 hours per year per building) x $21.16 per hour = $127 per year per building

APPENDIX C-13

THERMAL STORAGE

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: THERMAL STORAGE

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJE#3105.000
DATE: 07/17/92
FILE: ICE.WK3
PRPARED BDENNIS JONES
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
INCREMENTAL GAS COST	$4.67 MBtu	14.45 UPWG
INCREMENTAL ELECTRIC COST	$0.0255 kWh	11.11 UPWE
ELECTRIC DEMAND CHARGE	$102.66 kW	10.59 UPW
ECONOMIC LIFE	15 YRS	

BUILDING NUMBER	FLOOR AREA (ft2)	ICE CHILLER SIZE (TONS)	REQD STORAGE SIZE (TON-HRS)	ACTUAL STORAGE SIZE (TON-HRS)	STORAGE COST ($)	ICE CHILLER COST ($)	LABOR & MATERIAL COST ($)	TOTAL COST ($)
60	20,856	20	111	115	5,400	16,525	36,500	58,425
170	35,000	50	248	380	15,000	32,200	91,250	138,450
171	35,000	50	248	380	15,000	32,200	91,250	138,450
181	36,293	40	210	380	15,000	27,175	73,000	115,175
184	38,558	40	205	380	15,000	27,175	73,000	115,175
200	371,428	400	6,000	6,000	340,000	230,200	474,693	1,044,893
246	25,798	30	154	190	7,500	20,000	54,750	82,250
500	22,466	40	205	380	15,000	27,175	73,000	115,175

BUILDING NUMBER	FLOOR AREA (FT2)	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWH)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND SAVINGS ($)	ANNUAL NON-ENE SAVINGS ($)	TOTAL ANNUAL SAVINGS ($)	CONST. COST	SIR	SIMPLE PAYBACK (YRS)
60	20,856	22	(9,399)	0	(32)	($240)	$2,259	$0	$2,019	65,144	0.3	32.3
170	35,000	60	(16,296)	0	(56)	($416)	$6,160	$0	$5,744	154,372	0.4	26.9
171	35,000	60	(16,296)	0	(56)	($416)	$6,160	$0	$5,744	154,372	0.4	26.9
181	36,293	52	(33,926)	0	(116)	($865)	$5,338	$0	$4,473	128,420	0.4	28.7
184	38,558	66	(19,857)	0	(68)	($506)	$6,776	$0	$6,269	128,420	0.5	20.5
200	371,428	673	(138,284)	0	(472)	($3,526)	$69,090	$0	$65,564	1,165,056	0.6	17.8
246	25,798	83	(19,847)	0	(68)	($506)	$8,521	$0	$8,015	91,709	0.9	11.4
500	22,466	46	(13,122)	0	(45)	($335)	$4,722	$0	$4,388	128,420	0.4	29.3

E M C ENGINEERS, INC.
Denver • Colorado Springs • Atlanta • Germany

CALCULATED BY DATE
CHECKED BY DATE
SCALE

ECO 13

G101

Floor Area = 120,182 ft^2
Tank Capacity = 751 ton*hrs
Chiller Capacity = 125 tons
Demand Savings = 126 kw
Electricity Used = 39,069 kwh/yr

M 060

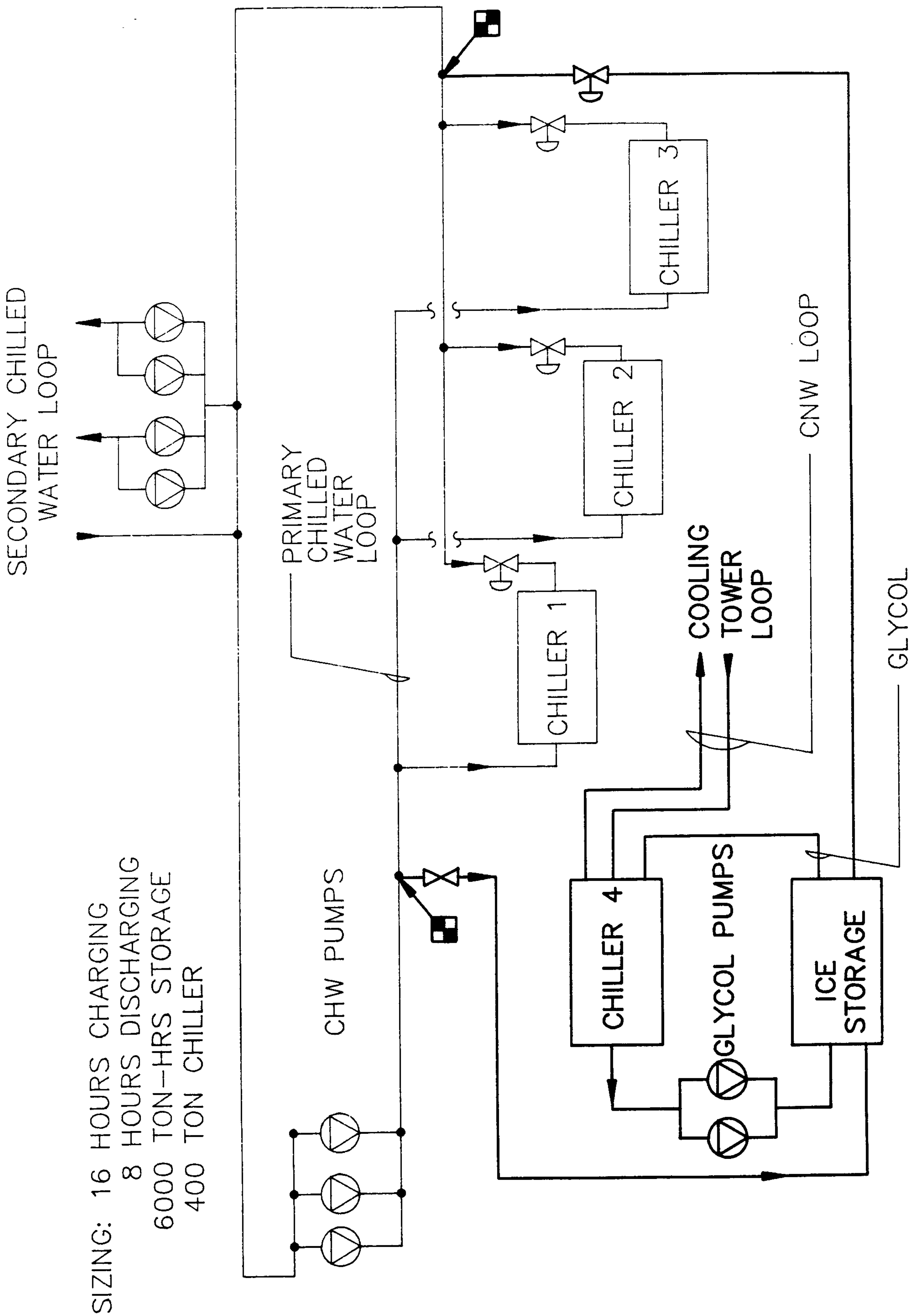
Floor Area = 20,856 ft^2
Tank Capacity = 111 ton*hrs
Chiller Capacity = 20 tons
Demand Savings = 22 kw
Electricity Used = 9399 kwh/yr

M 170/171

Floor Area = 35,398 ft^2
Tank Capacity = 248 ton*hrs
Chiller Capacity = 45 tons
Demand Savings = 60 kw
Electricity Used = 16,246 kwh/yr

M 500

Floor Area = 27,466 ft^2
Tank Capacity = 205 ton*hrs
Chiller Capacity = 35 tons
Demand Savings = 46 kw
Electricity Used = 13,122 kwh/yr


SIZING: 16 HOURS CHARGING
8 HOURS DISCHARGING
6000 TON-HRS STORAGE
400 TON CHILLER
SECONDARY CHILLED WATER LOOP
CHW PUMPS
PRIMARY CHILLED WATER LOOP
CHILLER 1
CHILLER 2
CHILLER 3
CNW LOOP
COOLING TOWER LOOP
GLYCOL
CHILLER 4
GLYCOL PUMPS
ICE STORAGE

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

X CODE A ☐ CODE B ☐ CODE C ☐ OTHER ______

EFFECTIVE PRICING DATE APR 92

DATE PREPARED 22-Apr-92

DRAWING NO.

SHT OF

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

ESTIMATOR RMG

CHECKED BY CEL

	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
AIR COOLED CHILLER (40 TON)	1	EA											
CALMAC ICE STORAGE TANKS	2	EA											
SYSTEM INSTALLATION, PIPING, STARTUP													
SUBTOTAL													
OVERHEAD, BOND	15%												
PROFIT	10%												
COST SUB-TOTAL													
CONTINGENCY	15%												
TOTAL											$115,000		

DA FORM 5418-R, APR 85

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

INVITATION NO./CONTRACT NO.
DACA 21-91-C-0097

X CODE A ☐ CODE B ☐ CODE C
☐ OTHER

EFFECTIVE PRICING DATE APR 92

DRAWING NO.

ESTIMATOR RMG

DATE PREPARED 22-Apr-92

SHT OF

CHECKED BY CEL

	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
AIR COOLED CHILLER (50 TON)	1	EA											
CALMAC ICE STORAGE TANKS	2	EA											
SYSTEM INSTALLATION, PIPING, STARTUP													
SUBTOTAL													
OVERHEAD, BOND	15%												
PROFIT	10%												
COST SUB-TOTAL													
CONTINGENCY	15%										$123,000		
TOTAL													

DA FORM 5418-R, APR 85

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

X CODE A ☐ CODE B ☐ CODE C ☐ OTHER

EFFECTIVE PRICING DATE APR 92

DATE PREPAR 22-Apr-92

DRAWING NO.

SHT OF

ESTIMATOR RMG

CHECKED BY

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

BLDG. 200 THERMAL STORAGE	Quantity			LABOR			EQUIPMENT		MATERIAL		TOTAL	SHIPPIN
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt
STORAGE TANK	2	EA			$5,000.00	$10,000.00			$165,000.00	$330,000.00	$340,000.00	
EXCAVATION FOR TANKS	1	LS				$15,000.00			$10,000.00	$10,000.00	$25,000.00	
CHW PIPING 8"	400	FT	0.8	320	$20.88	$6,681.60			$18.60	$7,440.00	$14,121.60	
VALVES AND FITTINGS	1	LS	90	90	$20.88	$1,879.20			$25,000.00	$25,000.00	$26,879.20	
TOWER CONNECTION, PUMP, PIPE	1	LS									$43,000.00	
GLYCOL PUMP	2	EA	15	30	$20.88	$626.40			1,500	$3,000.00	$3,626.40	
VALVES, STRAINERS, FITTINGS	1	LS	90	90	$20.88	$1,879.20			25,000	$25,000.00	$26,879.20	
GLYCOL PIPING 5"	100	FT	0.5	50	$20.88	$1,044.00			11	$1,132.00	$2,176.00	
CONTROLS	1	LS				$5,000.00					$5,000.00	
STARTUP	1	LS				$10,000.00					$10,000.00	
SCREW COMP. CHILLER, 400 TONS	1	EA				$30,200.00			200,000	$200,000.00	$230,200.00	
SUBTOTAL						$82,310.40				$601,572.00	$726,882.40	
OVERHEAD, BOND	15%					$12,346.56				$90,235.80	$109,032.36	
PROFIT	10%					$8,231.04				$60,157.20	$72,688.24	
COST SUB-TOTAL						$102,888.00				$751,965.00	$908,603.00	
CONTINGENCY	15%					$15,433.20				$112,794.75	$136,290.45	
TOTAL						$118,321.20				$864,759.75	$1,044,893.45	

DA FORM 5418-R, APR 85

Fax Cover Sheet

YORK INTERNATIONAL CORP.
1750 Corporate Dr., Suite 750
Norcross, Ga.
30093
PHONE: (404) 925-1002
FAX: (404) 925-3257

Fax Cover Sheet

Company Name:	EMC
Contact Name:	Carl Lundstrom
Fax Number:	951-0278

Sender:	Stu Guenther
Description:	Info on Ice storage for Ft ~~Benning~~ McPherson

Iceballs and Tank(s) for 6000 T-HR System $330,000
400T Screw Chiller to support system $200,000
Prices do not include system controls, valves, piping, or Brine

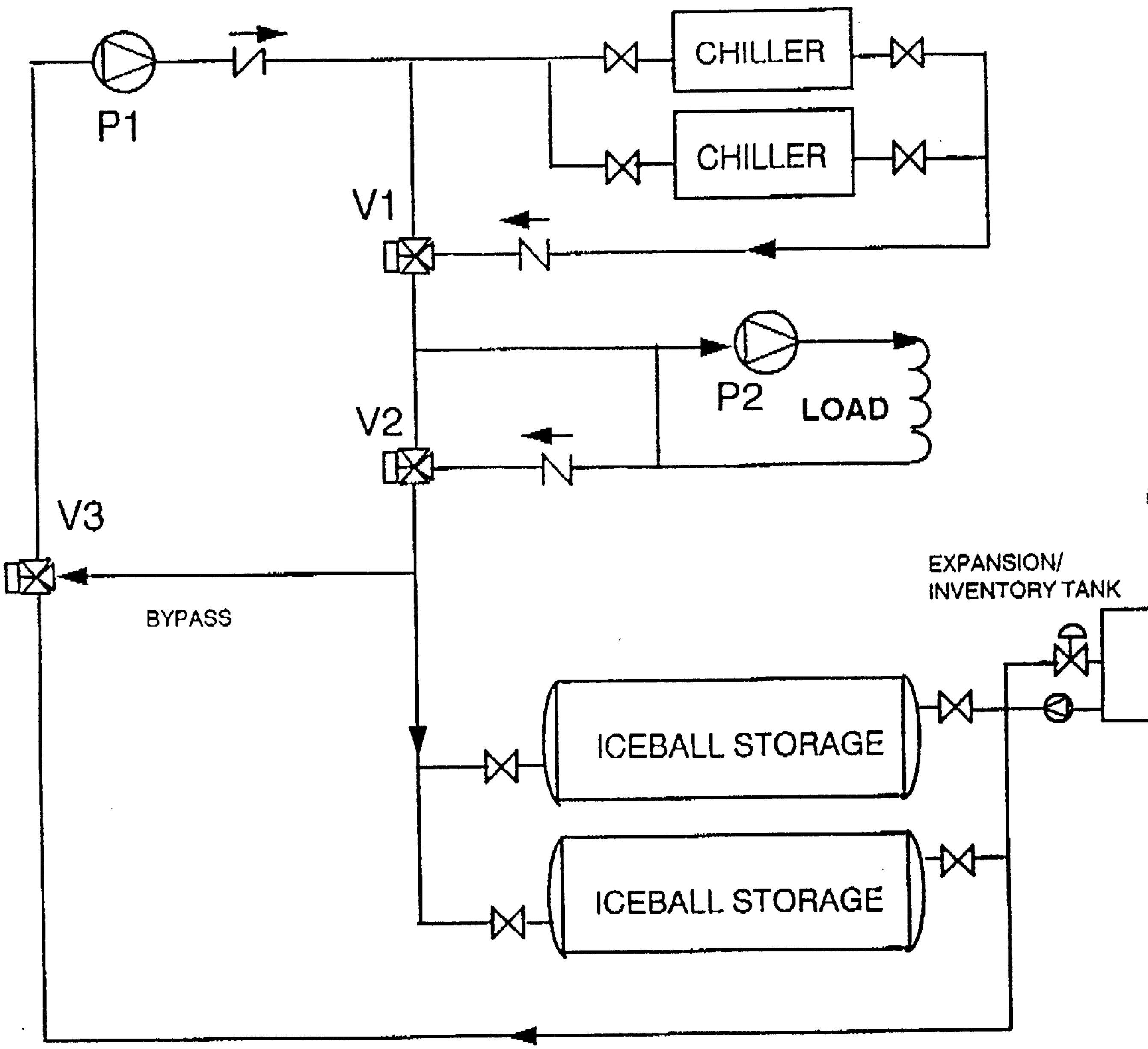
Call if you have any questions. Attached is a schematic cut sheet of a typical System

V/R
Stu

Number of pages:	2 (Including this page)
Date Sent:	21 APR 92

If there are any problems with this transmission, please call:

Typical Piping & Control Schematic
Pressure Vessels
Storage Priority



NOTE - THREE WAY VALVES (V1,V2,V3) CAN EACH BE REPLACED WITH TWO (2) TWO WAY VALVES AT THE DESIGNER'S DISCRETION

HAYNES TRANE

5654 Greenwood Plaza Blvd.
Englewood, Colorado 80111-2386
303/779-0787
303/779-0714 (FAX)

DATE: 4/12/92

TIME: 11:30

Please transmit to Facsimile Number: ~~966~~ 985-2527

Please deliver to: DENNIS JONES

Total number of pages being sent: 4 (including this page)

Notes: DENNIS –

THESE ARE MY BEST ESTIMATES.

From: ROGER

If you do not receive all pages, please call 779-0787 TRANE

TRANE

PROPOSAL

The Trane Company
A Division of
American Standard Inc.

TRANE COMPANY
5654 GREENWOOD PLAZA BLVD.
ENGLEWOOD, COLORADO 80111-2385

Customer
EMC ENGINEERS
FAX NO:

ATTN: DENNIS JONES

Number
ATLANTA

Date
4/10/92

Job Name
FORT MCPHERSON

Delivery Terms
FOB: FACTORY FREIGHT ALLOWED

Terms of Payment
NET: 30 DAYS

Engineer
EMC ENGINEERS

BUILDING 181 BUDGET

ITEM: A QTY: 1 DESCRIPTION: TRANE AIR COOLED CHILLER
TAG (S):
40 TON

> 40 TON A/C COLD GENERATOR
> ICE MAKING CONTROL MICROPROCESSOR
> UL LISTED
> PRESSURE GAUGES
> FLOW SWITCH
> CONTROL POWER TRANSFORMER

ITEM: B QTY: 2 DESCRIPTION: CALMAC ICE STORAGE TANKS
TAG (S):

> QTY: 2 - MODEL 1190 TANKS
> SYTEM INSTALLATION, PIPING, STARTUP

TOTAL NET PRICE ITEMS A TO B .... $ 115,000

Effective March, 1987, price increase terms will be administered as follows:
Prices stated in this proposal are firm provided that notification of release for immediate production and shipment is received at the factory not later than five months from order receipt. If such release is received later than five months from order receipt date but within eight months of order receipt date, prices will be increased a straight 1.0 percent (not compounded) for each one-month period (or part thereof) beyond the five-month firm price period up to the date of receipt of such release. If such release is not received within eight months after date of order receipt, the prices are subject to renegotiation or at the Company's option, the order will be cancelled. If for any reason Buyer delays shipment after release, prices are subject to increase as stated on the reverse side hereof.

Prices do not include taxes. See reverse side for terms and conditions of sale upon which this proposal is based.

1-26.130-4—(486)
Supersedes 1-26.130-4—(187)

TRANE

PROPOSAL

The Trane Company
A Division of American Standard Inc.

Number ATLANTA

BUILDING 184 BUDGET

ITEM: C QTY: 1 DESCRIPTION: TRANE AIR COOLED CHILLER
TAG (S):
50 TON

> 50 TON A/C COLD GENERATOR
> ICE MAKING CONTROL MICROPROCESSOR
> UL LISTED
> PRESSURE GAUGES
> FLOW SWITCH
> CONTROL POWER TRANSFORMER

ITEM: D QTY: 2 DESCRIPTION: CALMAC ICE STORAGE TANKS
TAG (S):

> QTY: 2 - MODEL 1190 TANKS
> SYTEM INSTALLATION, PIPING, STARTUP

TOTAL NET PRICE ITEMS C TO D .... $ 123,000

BUILDING GT6 BUDGET

ITEM: E QTY: 1 DESCRIPTION: TRANE AIR COOLED CHILLER
TAG (S):
40 TON

> 40 TON A/C COLD GENERATOR
> ICE MAKING CONTROL MICROPROCESSOR
> UL LISTED
> PRESSURE GAUGES
> FLOW SWITCH
> CONTROL POWER TRANSFORMER

C-13.11

ITEM: F QTY: 2 DESCRIPTION: CALMAC ICE STORAGE TANKS
TAG (S):

TRANE

PROPOSAL

The Trane Company
A Division of American Standard Inc.

Number ATLANTA

Page 3

> QTY: 2 - MODEL 1190 TANKS
> SYTEM INSTALLATION, PIPING, STARTUP

TOTAL NET PRICE ITEMS E TO F .... $ 115,000

State and Local taxes are not included in above price

RESPECTFULLY SUBMITTED,

RCH

ROGER C. HUBERT
SALES ENGINEER

ROJECT: FORT MCPHERSON

NALYSIS BY: DAN McGUINNESS

ROGER HUBERT - HAYNES TRANE
5654 GREENWOOD PLAZA BLVD.
ENGLEWOOD, CO 80111-2385
(303) 779-0787

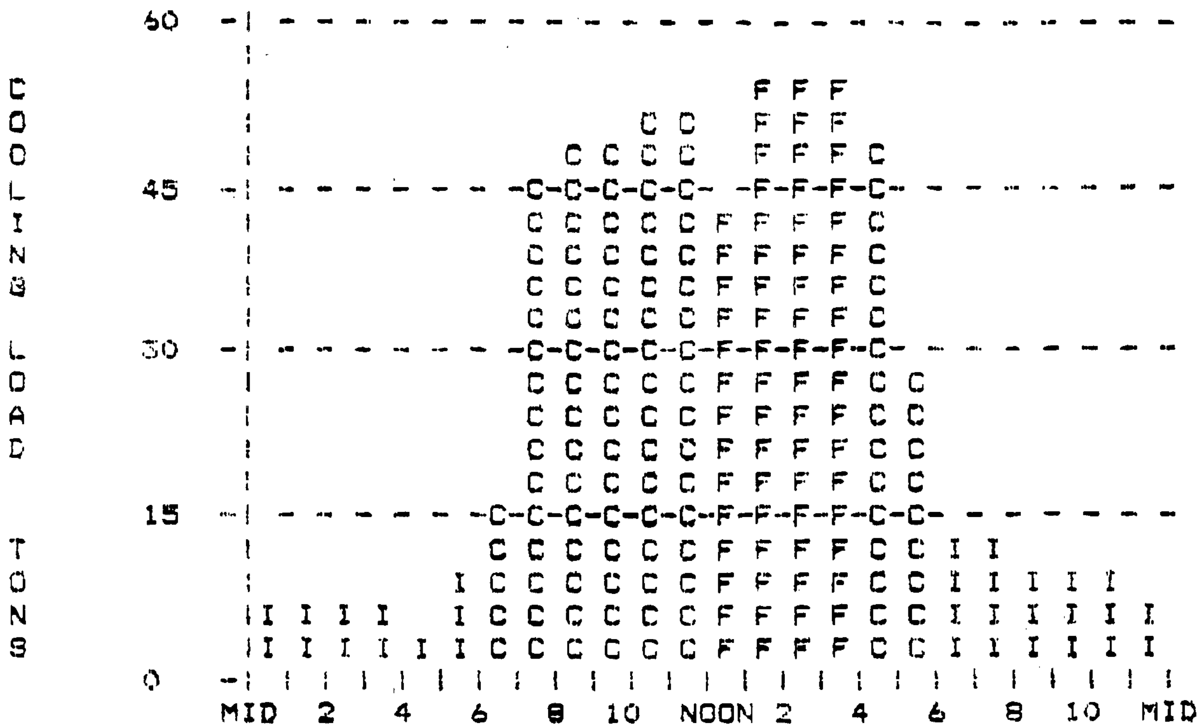
ILE #DEN005BD
_DG. 184

4-10-1992

(C) Calmac Mfg. Corp., 1990.
All Rights Reserved.

DESIGN DAY LOAD DATA

HOUR	LOAD	TYPE	CHILL %	HOUR	LOAD	TYPE	CHILL %
1	6.30	I	65.0	13	42.20	F	0.0
2	5.60	I	65.0	14	54.10	F	0.0
3	5.00	I	65.0	15	53.70	F	0.0
4	4.60	I	65.0	16	54.60	F	0.0
5	4.40	I	65.0	17	48.20	P	100.0
6	8.90	I	65.0	18	28.00	P	100.0
7	16.30	P	100.0	19	11.80	I	65.0
8	46.40	P	100.0	20	11.00	I	65.0
9	48.10	P	100.0	21	9.90	I	65.0
10	49.50	P	100.0	22	8.80	I	65.0
11	50.80	P	100.0	23	7.80	I	65.0
12	50.20	P	100.0	24	6.90	I	65.0



HOUR OF DAY

LEVLOAD TANK MODEL	1190
DESIGN LOAD	54.6
SYSTEM SUPPLY TEMPERATURE (DEG F)	45
SYSTEM RETURN TEMPERATURE (DEG F)	55
DEFAULT CHILLER COOLING CAPACITY (% OF NOMINAL)	100
DEFAULT CHILLER ICEMAKING CAPACITY (% OF NOMINAL)	65
NUMBER OF COOLING HOURS	12
NUMBER OF ICE-MAKING HOURS	12
TOTAL COOLING LOAD (TONS-HRS)	633.1

NOM CHLR TONS	COOL CAP TONS	ICE CAP TONS	STRG DIV	ESTMTD TON HOURS	STRG INLET DEG F	STRG OUT DEG F	PEAK STRG TONS	MIN # TANKS	MAX # TANKS
42.67	42.67	27.73	0.37	129.00	55.00	45.00	54.60	1.87	1.87
60.00	60.00	39.00	0.31	128.00	55.00	45.00	54.60	1.60	2.95

DESIGN DAY SYSTEM ANALYSIS

HI[illegible]R UPSTREAM - SERIES FLOW
YS[illegible]M SUPPLY TEMPERATURE = 45.0
YSTEM RETURN TEMPERATURE = 55.0
LOW (GPM) - DISCHARGE = 139.2
ELTA P (PSI) - DISCHARGE = 9.2

NOMINAL CHILLER SIZE = 60.0
NUMBER OF TANKS = 2 MODEL 1190
DESIGN LOAD = 54.6 TONS
CHARGE = 139.2
CHARGE = 10.5

OUR & YPE	LOAD TONS	CHLR TONS	STRG TONS	TANK TONS	TN-HRS TOTAL	TN-HRS/ TANK	% CHARGE	CHLR TEMP	REQD STRG TEMP	AVLB MIN TEMP	RET TEMP	GPM PER TANK	PD PSI	FG
1 I	6	39	33	16.3	210	105.2	55.4	24.5	30.5	30.5	31.7	69.6	10.6	
2 I	6	39	33	16.7	244	121.9	64.2	23.7	29.8	29.8	30.8	69.6	10.6	
3 I	5	39	34	17.0	278	138.9	73.1	22.6	28.8	28.8	29.7	69.6	10.7	
4 I	5	39	34	17.2	312	156.1	82.2	21.3	27.6	27.6	28.4	69.6	10.7	
5 I	4	39	35	17.3	347	173.4	91.3	19.7	26.0	26.0	26.8	69.6	10.8	
6 I	9	22	13	6.6	360	180.0	94.7	****	****	****	****	69.6	****	
7 P	16	16	0	0.0	360	180.0	94.7	45.0	45.0	32.0	48.0	0.0	****	
8 P	46	46	0	0.0	360	180.0	94.7	45.0	45.0	32.0	53.5	0.0	****	
9 P	48	48	0	0.0	360	180.0	94.7	45.0	45.0	32.0	53.8	0.0	****	
0 P	49	49	0	0.0	360	180.0	94.7	45.0	45.0	32.0	54.1	0.0	****	
1 P	51	51	0	0.0	360	180.0	94.7	45.0	45.0	32.0	54.3	0.0	****	
2 P	50	50	0	0.0	360	180.0	94.7	45.0	45.0	32.0	54.2	0.0	****	
3 F	42	0	-42	-21.1	318	158.9	83.6	52.7	45.0	33.3	52.7	27.7	2.6	
4 [illegible]	54	0	-54	-27.1	264	131.8	69.4	54.9	45.0	35.7	54.9	36.0	3.5	
5 [illegible]	54	0	-54	-26.9	210	105.0	55.3	54.8	45.0	37.3	54.8	39.1	3.9	
.6 F	55	0	-55	-27.3	155	77.7	40.9	55.0	45.0	39.5	55.0	44.9	4.7	
.7 P	48	48	0	0.0	155	77.7	40.9	45.0	45.0	32.0	53.8	0.0	****	
.8 P	28	28	0	0.0	155	77.7	40.9	45.0	45.0	32.0	50.1	0.0	****	
.9 I	12	39	27	13.6	27	13.6	7.2	26.8	31.8	31.8	34.0	69.6	10.4	
20 I	11	39	28	14.0	55	27.6	14.5	26.6	31.7	31.7	33.7	69.6	10.5	
21 I	10	39	29	14.5	84	42.1	22.2	26.3	31.6	31.6	33.5	69.6	10.5	
22 I	9	39	30	15.1	114	57.2	30.1	26.0	31.5	31.5	33.1	69.6	10.5	
23 I	8	39	31	15.6	146	72.8	38.3	25.6	31.3	31.3	32.8	69.6	10.5	
24 I	7	39	32	16.0	178	88.9	46.8	25.1	31.0	31.0	32.3	69.6	10.5	

TANK DISCHARGE PROFILE

HOUR & TYPE	TONS PER TANK	INLET TEMP DEG.F	OUTLET TEMP DEG.F	PERCENT TANK DISCH.	OUT OF RANGE
13 F	21.1	52.7	45.0	11.1	
14 F	27.0	54.9	45.0	25.3	
15 F	26.9	54.8	45.0	39.5	
16 F	27.3	55.0	45.0	53.8	

- FLOW ANALYSIS - 60 TON CHILLER - 2 MODEL 1190 STORAGE TANKS

CHG dT	CHG GPM	GPM/TANK	dP(PSI)	AVG LCWT	MIN LCWT
3.0	331.5	165.8	****	****	****
4.0	248.6	124.3	****	****	****
5.0	198.9	99.4	19.2	23.7	20.7
6.0	165.8	82.9	14.1	23.0	20.3
7.0	142.1	71.0	10.9	22.4	19.9
8.0	124.3	62.2	8.8	21.7	19.5
9.0	110.5	55.3	7.3	21.0	19.1
10.0	99.4	49.7	6.2	20.2	18.7

DIS dT	DIS GPM	GPM/TANK	dP(PSI)
8.0	174.0	87.0	12.6
9.0	154.7	77.3	10.4
10.0	139.2	69.6	8.7
11.0	126.6	63.3	7.5
12.0	116.0	58.0	6.5
13.0	107.1	53.5	5.7
14.0	99.4	49.7	5.1
15.0	92.8	46.4	4.6

PROJECT: FORT MCPHERSON

ANALYSIS BY: DAN McGUINNESS

ROGER HUBERT - HAYNES TRANE
5654 GREENWOOD PLAZA BLVD.
ENGLEWOOD, CO 80111-2385
(303) 779-0787

FILE #DEN005CD
BLDG. GT6

04-10-1992

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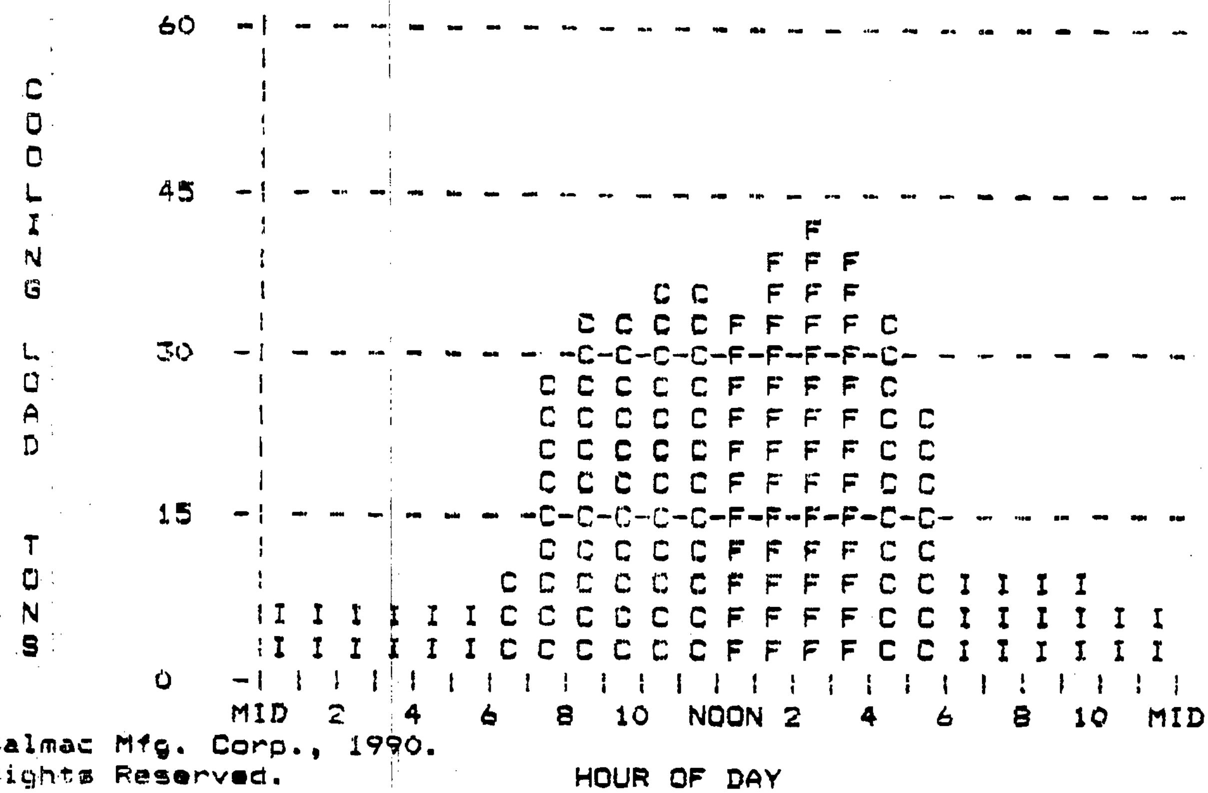
DESIGN DAY LOAD DATA

HOUR	LOAD	TYPE	CHILL %	HOUR	LOAD	TYPE	CHILL %
1	7.20	I	65.0	13	32.80	F	0.0
2	6.40	I	65.0	14	39.40	F	0.0
3	5.90	I	65.0	15	41.30	F	0.0
4	5.50	I	65.0	16	40.30	F	0.0
5	5.40	I	65.0	17	34.50	P	100.0
6	7.40	I	65.0	18	23.20	P	100.0
7	10.20	P	100.0	19	10.10	I	65.0
8	26.70	P	100.0	20	9.20	I	65.0
9	32.10	P	100.0	21	8.50	I	65.0
10	34.00	P	100.0	22	7.90	I	65.0
11	35.00	P	100.0	23	7.40	I	65.0
12	35.70	P	100.0	24	7.00	I	65.0



LEVLOAD TANK MODEL	1190
DESIGN LOAD	41.3
SYSTEM SUPPLY TEMPERATURE (DEG F)	45
SYSTEM RETURN TEMPERATURE (DEG F)	55
DEFAULT CHILLER COOLING CAPACITY (% OF NOMINAL)	100
DEFAULT CHILLER ICEMAKING CAPACITY (% OF NOMINAL)	65
NUMBER OF COOLING HOURS	12
NUMBER OF ICE-MAKING HOURS	12
TOTAL COOLING LOAD (TONS-HRS)	473.1

NOM CHLR TONS	COOL CAP TONS	ICE CAP TONS	STRG DIV	ESTMTD TON HOURS	STRG INLET DEG F	STRG OUT DEG F	PEAK STRG TONS	MIN # TANKS	MAX # TANKS
32.28	32.28	20.98	0.33	128.30	55.00	45.00	41.30	1.28	1.28
65.00	65.00	42.25	0.31	128.30	55.00	45.00	41.30	1.20	3.27

DESIGN DAY SYSTEM ANALYSIS

CHILLER UPSTREAM - SERIES FLOW
SYSTEM SUPPLY TEMPERATURE = 45.0
SYSTEM RETURN TEMPERATURE = 55.0
FLOW (GPM) - DISCHARGE = 105.3
DELTA P (PSI) - DISCHARGE = 5.9

NOMINAL CHILLER SIZE = 65.0
NUMBER OF TANKS = 2 MODEL 1190
DESIGN LOAD = 41.3 TONS
CHARGE = 105.3
CHARGE = 6.7

HOUR & TYPE	LOAD TONS	CHLR TONS	STRG TONS	TANK TONS	TN-HRS TOTAL	TN-HRS/ TANK	% CHARGE	CHLR TEMP	REQD STRG TEMP	AVLB MIN TEMP	RET TEMP	GPM PER TANK	PD PSI	FB
1 I	7	42	35	17.5	238	119.2	62.7	21.8	30.3	30.3	32.0	52.7	6.8	
2 I	6	42	36	17.9	274	137.1	72.2	20.9	29.6	29.6	31.1	52.7	6.9	
3 I	6	42	36	18.2	311	155.3	81.7	19.8	28.6	28.6	30.1	52.7	6.9	
4 I	5	42	37	18.4	347	173.7	91.4	18.6	27.5	27.5	28.8	52.7	6.9	
5 I	5	18	13	6.3	360	180.0	94.7	23.[illegible]	26.3	26.3	27.6	52.7	6.9	
6 I	7	7	0	0.0	360	180.0	94.7	****	****	****	****	52.7	****	
7 P	10	10	0	0.0	360	180.0	94.7	45.0	45.0	32.0	47.5	0.0	****	
8 P	27	27	0	0.0	360	180.0	94.7	45.0	45.0	32.0	51.5	0.0	****	
9 P	32	32	0	0.0	360	180.0	94.7	45.0	45.0	32.0	52.8	0.0	****	
10 P	34	34	0	0.0	360	180.0	94.7	45.0	45.0	32.0	53.2	0.0	****	
11 P	35	35	0	0.0	360	180.0	94.7	45.0	45.0	32.0	53.5	0.0	****	
12 P	36	36	0	0.0	360	180.0	94.7	45.0	45.0	32.0	53.6	0.0	****	
13 F	33	0	-33	-16.4	327	163.6	86.1	52.9	45.0	32.8	52.9	20.7	1.9	
14 [illegible]	39	0	-39	-19.7	288	143.9	75.7	54.5	45.0	33.7	54.5	24.1	2.2	
15 [illegible]	41	0	-41	-20.7	247	123.3	64.9	55.0	45.0	34.6	55.0	25.8	2.3	
16 F	40	0	-40	-20.2	206	103.1	54.3	54.8	45.0	35.5	54.8	26.7	2.4	
17 P	34	34	0	0.0	206	103.1	54.3	45.0	45.0	32.0	53.4	0.0	****	
18 P	23	23	0	0.0	206	103.1	54.3	45.0	45.0	32.0	50.6	0.0	****	
19 I	10	42	32	16.1	32	16.1	8.5	24.1	31.9	31.9	34.3	52.7	6.7	
20 I	9	42	33	16.5	65	32.6	17.2	23.8	31.8	31.8	34.0	52.7	6.8	
21 I	8	42	34	16.9	99	49.5	26.0	23.5	31.7	31.7	33.7	52.7	6.8	
22 I	8	42	34	17.2	133	66.6	35.1	23.2	31.5	31.5	33.4	52.7	6.8	
23 I	7	42	35	17.4	168	84.1	44.2	22.8	31.2	31.2	33.0	52.7	6.8	
24 I	7	42	35	17.6	203	101.7	53.5	22.3	30.8	30.8	32.5	52.7	6.8	

TANK DISCHARGE PROFILE

HOUR & TYPE	TONS PER TANK	INLET TEMP DEG.F	OUTLET TEMP DEG.F	PERCENT TANK DISCH.	OUT OF RANGE
13 F	16.4	52.9	45.0	8.6	
14 F	19.7	54.5	45.0	19.0	
15 F	20.6	55.0	45.0	29.9	
16 F	20.1	54.8	45.0	40.5	

- FLOW ANALYSIS - 65 TON CHILLER - 2 MODEL 1190 STORAGE TANKS

CHG dT	CHG GPM	GPM/TANK	dP(PSI)	AVG LCWT	MIN LCWT
3.0	359.1	179.6	****	****	****
4.0	269.3	134.7	****	****	****
5.0	215.5	107.7	22.0	23.3	20.2
6.0	179.6	89.8	16.1	22.6	19.8
7.0	153.9	77.0	12.4	22.0	19.5
8.0	134.7	67.3	10.0	21.3	19.0
9.0	119.7	59.9	8.2	20.6	18.7
10.0	107.7	53.9	7.0	19.9	18.3

DIS dT	DIS GPM	GPM/TANK	dP(PSI)
8.0	131.6	65.8	8.0
9.0	117.0	58.5	6.6
10.0	105.3	52.7	5.6
11.0	95.7	47.9	4.8
12.0	87.8	43.9	4.2
13.0	81.0	40.5	3.8
14.0	75.2	37.6	3.4
15.0	70.2	35.1	3.1

TYPICAL ICE STORAGE DESIGN

I. Determine type of storage system.

The type of storage system, e.g., partial or full storage*, chiller or ice priority, with or without eutectic salts, etc., is generally determined by economic and site considerations, such as utility rate structures, acceptable payback, retrofit vs. new construction and available space, to name a few.

Since chiller sizing and tank selection are straightforward for full storage, we will choose a partial storage, chiller priority system for our example.

II. Establish a system configuration.

There are three basic system designs:

1. *Series flow, storage upstream.* (Figure 1.) Recoverable cooling storage is maximized but chiller inlet temperature is depressed. Control strategies and piping are simplified.
2. *Series flow, chiller upstream.* (Figure 2.) Chiller operates at a very high capacity and efficiency. Recoverable storage is decreased slightly. Also provides simplified control and piping.
3. *Parallel flow.* (Figure 3.) Both chiller and storage receive the benefit of high return temperature liquid. Chiller operates at high capacity and efficiency and recoverable storage is maximized. System pressure drop is reduced although controls and piping can be more complex than for series systems.

For our example, assume a series flow system, chiller upstream, with 45F supply and 60F return temperatures.

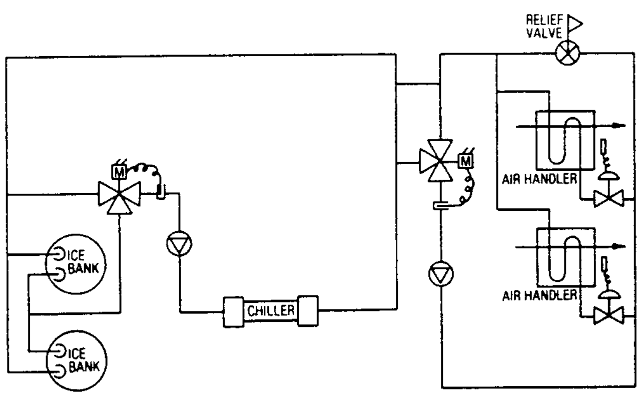


Figure 1. Series flow, storage upstream.

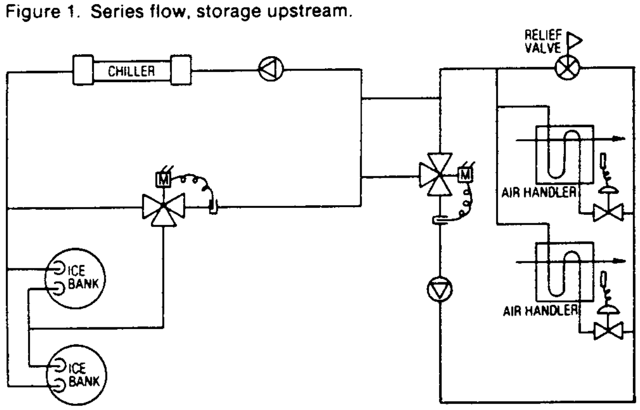


Figure 2. Series flow, chiller upstream.

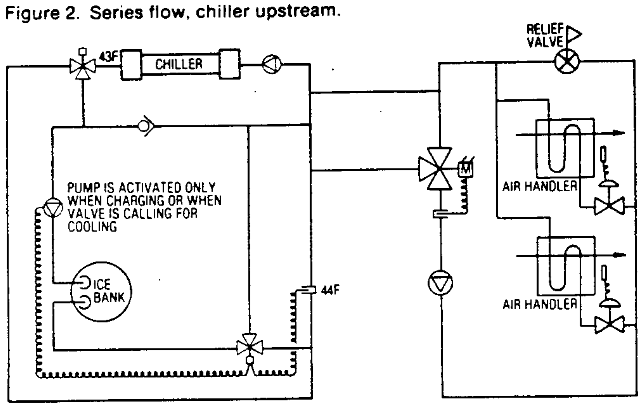


Figure 3. Parallel flow.

III. Determine System Ton-Hours (STH).

Required ton-hours for the daily cooling period are calculated as follows:

Where Design Load = 1000 tons, Diversity = .85, and Number of Cooling Hours (occupied period + precool hours) = 10.

STH = Design Load x Diversity x Number of Cooling Hours

STH = 1000 tons x .85 x 10 hours = 8500 ton-hours

Alternatively, if hourly building loads are available from a building load profile, as in Figure 4, these can be summed up to give total System Ton-Hours.

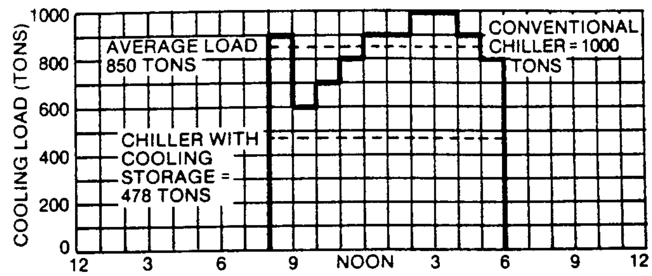


Figure 4. Building Load Profile.

IV. Determine Nominal Chiller Size (NCS).

All chiller capacities are referenced to standard conditions. Therefore, the chiller tonnage calculated for this section is the required capacity at standard rating conditions, not ice making conditions. Basically, we are looking for the chiller whose total capacity—daytime cooling + ice making—will equal the total system ton-hours required.

1. From manufacturer's data, determine the chiller's capacity at ice making condition (usually about 25F LCWT and 31F RCWT) as a percentage of its standard or nominal capacity (CAP_{ice}). A 1000-ton chiller that produces 650 tons at ice making conditions would be rated at .65. This is the figure we will use in the example.
2. Determine, from manufacturer's data, the chiller's capacity, as a percentage of its nominal capacity, for daytime cooling conditions (CAP_{occ}). Depending on system design, this number can be in excess of 1 or, for severe design conditions, may be slightly less than 1. For the example, a value of 1 will be used, which means that a 1000-ton nominal chiller will provide 1000 tons on a design day.
3. Determine the number of hours available to make ice. This will be dependent on the building's unoccupied period, utility off-peak periods, on-peak/off-peak rate differentials, etc. We will assume 12 hours for ice making.
4. Calculate minimum Nominal Chiller Size (NCS):

$$NCS = \frac{\text{System Ton-Hours}}{(CAP_{ice} \times \text{Icemaking Hrs.}) + (CAP_{occ} \times \text{Cooling Hrs.})}$$

$$NCS = \frac{\text{8500 Ton-Hours}}{(.65 \times 12) + (1 \times 10)} = 477.5 \text{ Tons}$$

For Full Storage, use 0 for Cooling Hours in the equation above.

V. Calculate the required number of Ice Banks.

The storage tanks must first be rated for the particular system conditions. This procedure is demonstrated on the bottom of page 3 in the "K-Factor" example for a *Parallel Flow* system. For our *Series Flow* example, we must calculate the temperature leaving the chiller and entering the tanks. At 1000 tons and a load Δt of 15 degrees (60F - 45F), the system flow for peak conditions will be:

$$GPM = \frac{\text{Tons} \times 25.5}{\Delta t} = \frac{1000 \times 25.5}{15} = 1700$$

The chiller Δt will be:

$$\Delta t = \frac{\text{Tons} \times 25.5}{GPM} = \frac{477.5 \times 25.5}{1700} = 7.16F$$

The temperature of the fluid entering the tanks will therefore be 60F - 7.16F = 52.84F. The leaving temperature will be 45F.

For 52.84 inlet and 45F outlet temperatures and a .85 diversity, the storage tanks (Model 1190) will deliver 86% (.86) of their nominal storage at a 19 ton rate.

The required storage is equal to the system ton-hours less the contribution of the chiller during the cooling period. The required

storage is then divided by the modified storage tank's capacity to achieve the proper number of tanks. Assume Model 1190 LEVLOAD Ice Banks, which are nominally rated for 190 ton-hours.

$$\text{Number of Ice Banks} = \frac{\text{STH - (NCS x Cooling Hours)}}{\text{Ton-Hours/Tank x K-Factor}}$$

$$\text{Number of Ice Banks} = \frac{8500 - (477.5 \times 10)}{190 \times .86} = 22.8 \text{ (Use 23 tanks)}$$

For Full Storage, use 0 for Cooling Hours in the equation above.

VI. Check results.

1. Compare chiller capacity to load curve. These formulas assume that the chiller is operating at full load for the entire day. If the building load drops below chiller capacity during the cooling period, the chiller will unload and the total contribution of the chiller will be reduced. Under these circumstances the chiller will be undersized, although this is generally not the case. For the present example, the minimum building load is 600 tons (see Figure 4) and the calculated chiller size will be adequate.

2. Verify assumed charge temperatures. Using the charging flow rate and ice making chiller capacity, we can determine the actual required Average Charging Brine Temperature (ACBT), which is the same as the LCWT of the chiller, from the charge curves and compare to the assumption in Step IV. If the charging time is unusually short, you may find that the ACBT has been depressed and your assumption of chiller ice making capacity may have to be revised.

After correcting the pump capacity for the fluid conditions at ice making temperatures (let's say 1600 GPM for our system), a charging Δt can be calculated:

Chiller capacity = 477.5 x .65 = 310.4 tons

$$\Delta t = \frac{310.4 \times 25.5}{1600} = 5F$$

Divide the assumed chiller capacity by the number of tanks to calculate a tons/tank charge rate:

$$\text{Tons/tank} = \frac{310.4 \text{ tons}}{23 \text{ tanks}} = 13.5$$

From the Model 1190 Charge Curve (page 12) at 13.5 tons/tank and a 5F Δt, find an ACBT of 25.2F, which agrees with our original assumption. The Minimum Charging Brine Temperature (at full charge) is 22.3F.

3. Check for excessive discharge rates. The storage adjustment factor (K-Factor) is calculated to allow for normally encountered variations in discharge rate (peak loads). However, if unusually large variations in peak load occur for short periods, the storage outlet temperature may rise above design. (Consult Calmac in these circumstances.) In our example, we used a K-Factor of .86 and a 19 ton discharge rate. However, the peak discharge rate per tank of our system is 22.7 tons [(1000 tons - 477.5 tons) ÷ 23 tanks] at 3:00 P.M. Since this is higher than 19 tons we must determine the average discharge rate *per tank* for the interval from peak to the final hour:

$$\frac{\text{(1000 T-H + 900 T-H + 800 T-H) - (477.5 Tons x 3 Hrs.)}}{\text{3 Hrs. x 23 Tanks}} = 18.4 \text{ Tons}$$

Since this is less than 19 tons, the design is valid.

4. Check Ice Bank pressure drop. Maximum storage pressure drop is generally encountered during the charge period.

Using the example:

$$\text{GPM/tank} = \frac{1600 \text{ GPM}}{23 \text{ tanks}} = 69.6$$

From the pressure drop curves (page 10), find storage pressure drop of 10.5 psi.

*See Glossary on last page for explanations of unfamiliar terms.

K-FACTOR EXAMPLE

Design Conditions:

1. Occupied Hours	10
2. Precool Hours	2
3. Diversity (Average Load ÷ Peak Load)	.75
4. LEVLOAD Model	1100
5. Storage Inlet Temp. (F)	60
6. Maximum Temp. from Storage (F)	45

Cooling Hours = Occupied Hours + Precool Hours
Adjusted Discharge Hours = Diversity x Cooling Hours
Cooling Hours = 10 + 2 = 12
Hours of Discharge = .75 x 12 = 9.0

1. On the Model 1100 Performance Discharge Curve for a CONSTANT INLET TEMP. = 60F, locate Hours of Discharge (9.0) along the horizontal axis.

2. Move vertically to the Blended Outlet Temperature point of 45 degrees. (Point A on Curve).

3. From Point A, move horizontally to the left to read the amount of total Ton-Hours available (90 TON-HOURS).

4. Move horizontally to the right to find the K-Factor which is used in our equations for designing the systems (.90).

5. Following a line up and to the right, read the Discharge Rate at which the tank was discharged for the 9 hours (10.0 TONS).

6. The flow rate for a one-tank system (GPM-sys) is calculated from the equation at bottom of Curve Sheet:

GPM = 25.5 x 10 tons/15F = 17

Model 1100 EXAMPLE 60F

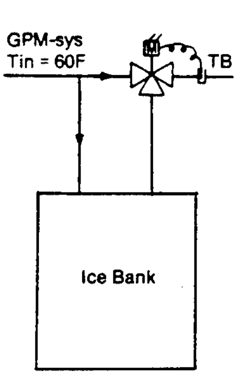
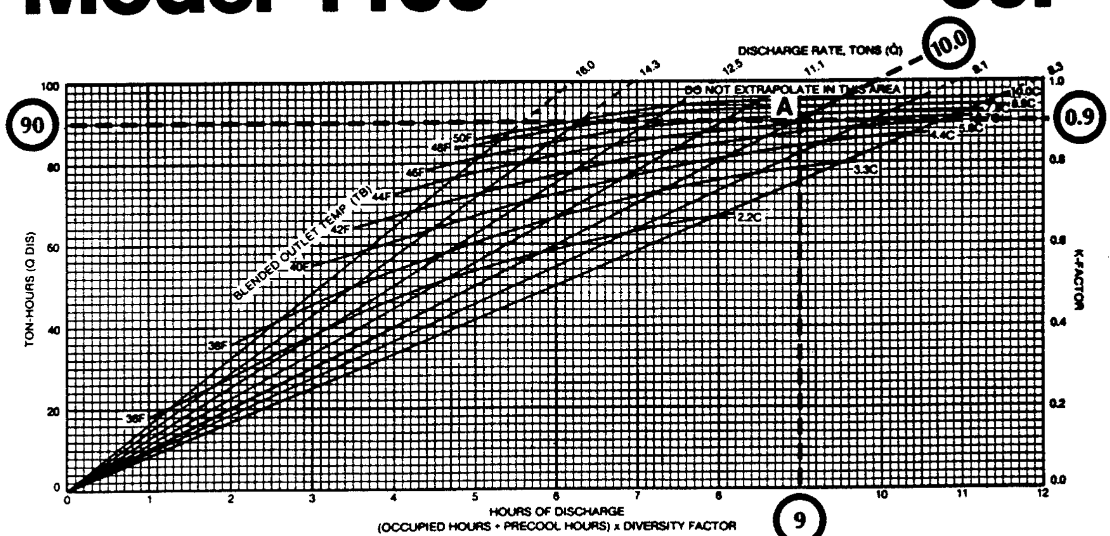


Figure 5. Blended outlet temperature



APPENDIX C-14.1

LOADING DOCK SEALS

(There were no applicable ECO's in the selected buildings for loading dock seals at Ft. McPherson)

APPENDIX C-14.2

INFRARED HEATERS

(There were no applicable ECO's in the selected buildings for infrared heaters at Ft. McPherson)

APPENDIX C-15.1

BUILDING 200 LIGHTING CONTROLS

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: MECO25
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-15 BLDG. 200 LIGHTING CONTRO
ANALYSIS DATE: 07-16-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	127770.
B. SIOH	$	7028.
C. DESIGN COST	$	7667.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	142465.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	2599.	$ 19418.	15.61	303118.
B. DIST	$ .00	0.	$ 0.	21.66	0.
C. RESID	$ .00	0.	$ 0.	26.51	0.
D. NAT G	$ 4.67	0.	$ 0.	23.77	0.
E. COAL	$ .00	0.	$ 0.	16.06	0.
F. TOTAL		2599.	$ 19418.		$ 303118.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 16734.
(1) DISCOUNT FACTOR (TABLE A) 14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 243145.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 243145.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 100029.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) 2.83
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 36152.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 546263.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 3.83
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 3.94

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT MCPHERSON
ECO: AUTOMATIC LIGHTING CONTROL IN BLDG-200

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 07/16/92
FILE: LITE200.WK3
PRPARED BY: DENNIS JONES
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
INCREMENTAL GAS COST	$4.67 MBtu	23.77 UPWG
INCREMENTAL ELECTRIC COST	$0.0255 kWh	15.61 UPWE
ELECTRIC DEMAND CHARGE	$102.66 kW	14.53 UPW
ECONOMIC LIFE	25 YRS	

BUILDING NUMBER	FLOOR AREA (ft2)	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWH)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND SAVINGS ($)	ANNUAL NON-ENE SAVINGS ($)	TOTAL ANNUAL SAVINGS ($)	CONST. COST ($)	SIR	SIMPLE PAYBACK (YRS)
200	274,244	163	761,510	0	2,599	19,419	16,734	0	36,152	142,464	3.8	3.9

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study LOCATION Ft. McPherson & Ft Gillem	INVITATION NO./CONTRACT NO. DACA 21-91-C-0097 [X] CODE A [ ] CODE B [ ] CODE C [ ] OTHER	EFFECTIVE PRICING DATE APR 92 DRAWING NO. ESTIMATOR RMG	DATE PREPARED 15-Jul-92 SHT OF CHECKED BY CEL

INDIVIDUAL OFFICES: SINGLE LEVEL LIGHTING CONTROL FROM OCCUPANCY SENSORS	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
#W 1000A-ULTRASONIC SENSOR	150	EA	3.31	496.5	$21.17	$10,510.91			$85.00	$12,750.00	$23,260.91		
POWER PACK #A277D	150	EA	0.95	142.5	$21.17	$3,016.73			$25.00	$3,750.00	$6,766.73		
REMOVE WALL SWITCH/WIRING	150	EA	0.95	142.5	$21.17	$3,016.73			$8.00	$1,200.00	$4,216.73		
SENSOR WIRING/CONNECTIONS	150	EA	0.48	72	$21.17	$1,524.24			$20.00	$3,000.00	$4,524.24		
ADD LV RELAY FOR REMOTE	–	–	DELETE OCCUPANCY										
TELEPHONE LTG CONTROL			SENSORS ONLY FOR OFFICES										
OPEN OFFICE AREAS													
PHONE OVERRIDE MODULE	12	EA	7.1	85.2	$21.17	$1,804			$900.00	$10,800	$12,604		
PROGRAMMABLE SYSTEM SWITCH	1	EA	23.4	23.4	$21.17	$495			$1,000.00	$1,000	$1,495		
LIGHTING AUTOMATION PANEL	12	EA	47.3	567.6	$21.17	$12,016			$2,000.00	$24,000	$36,016		
SYSTEM CONNECTION	1	LS							$1,500.00	$1,500	$1,500		
(EST. 1 PER SECMENT)													
PROGRAMMING	144	PNT			$150.00	$21,600.00					$21,600.00		
SUBTOTAL						$32,384				$56,500	$88,884		
OVERHEAD, BOND	15%					$4,858				$8,475	$13,333		
PROFIT	10%					$3,238				$5,650	$8,888		
COST SUB-TOTAL						$40,480				$70,625	$111,105		
CONTINGENCY	15%					$6,072				$10,594	$16,666		
TOTAL						$46,552				$81,219	$127,770		

DA FORM 5418-R, APR 85

COST200.WK3

MEMORANDUM

To: File, #3105.000
Fm: Ron Gerrans
Dt: 24 January 1992

Re: Bldg. 200, Helen Bradwell

We met with Helen Bradwell on 22 January 1992 to discuss building 200. The following information was discussed:

1. Lights: The lights are turned on by the first person in the area. The lights are supposed to be shut off by the last person to leave the area, but this seldom happens. The MP's turn off the lights during their rounds at 9:00. The janitorial staff comes through after that to clean the building, they turn the lights back on and usually do not turn them back off, even though they are supposed to. The MP's turn the lights back off during their 11:00 rounds. The exterior and parking lights are hooked up to the building power and use photocells to turn on and off.

2. Equipment: The central copy machines are on timers (6:00 a.m. to 6:00 p.m.), but the individual computers, copy machines, etc. are the responsibility of the individual to turn them off. They are usually shut off.

3. Occupancy: The times of occupancy vary, with the basement being on a 24 hour schedule, but the rest of the building on a normal 8:00 to 5:00 schedule. During the week there are approximately 1800 people in the building during the day, 100 during the night, and 200 - 300 on the weekends. During Desert Storm the entire building was occupied 24 hours per day. The equipment was only recently returned to normal operation.

4. Complaints: There is a problem in building 200 with keeping the occupants happy. It is common practice that if someone makes a complaint, they'll adjust their operations to make this one person happy.

Revise Lighting Control For Energy Savings

Individual offices lighting is presently controlled by local switching adjacent the doorways. There is no other control.

Wall switches and wiring to light fixtures will be removed. New occupancy sensors and power packs for connecting sensors to lighting fixtures will be installed to provide automatic lighting control switching by the occupancy sensor(s).

Occupancy sensor type, and locations for mounting whether wall or ceiling, will be reviewed on the configuration and size of individual offices.

It may be expected, based upon past projections and reports, the lighting energy consumptions of kilowatt-hours of power will be reduced 30-40 percent.

Open areas office spaces constitute approximately 70% of the building floor area.

Open office areas presently have lighting circuits controlled through low voltage relays mounted in low voltage relay panels adjacent building lighting panels from which the lighting circuits are derived.

Master selector switches for control of these lighting circuits are located in the open office areas.

For reduction of lighting in unoccupied areas and for energy savings the lighting control will be revised.

The existing low voltage lighting relay panels will be replaced by new "lighting automation panels" (LAPS) with provisions for automatic or telephone control.

LAPS will allow:

1. Remote control via telephone lines to control individual or all lighting control relays.
2. Control by new time clock which sweeps lighting on or off at preset times.
3. Local switch control via manual selector switches to remain.

JOB Ft. McPherson / Ft. Gillem ESOS Study

SHEET NO EMC # 3105.000 OF

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • Germany

CALCULATED BY DATE

CHECKED BY DATE

SCALE

Bldg. M-200 Lighting Control

Current Conditions

Energy Consumption

Overhead lighting = 600,316 W -from calculation

Floor Area = 274,200 ft^2

Task lighting = 0.67 W / ft^2 -from calculations

$$\text{TOTAL} = 0.67\ W/ft^2 + \frac{600{,}316\ W}{274{,}200\ ft^2} = 2.86\ w/ft^2$$

Lighting Schedule

	% lights on	
Hour	Weekdays	Weekends
0:00	5%	5%
7:00	80%	
8:00	100%	30%
12:00	80%	
13:00	100%	
16:00	80%	
17:00	60%	5%
21:00	30%	
23:00	5%	

-basement always 100% on

Savings

Enclosed Offices

30% of building is enclosed offices

Occupancy sensors in enclosed offices = 30% savings

-from ASHRAE 90

Savings = 30% * 30% * 600,316 W = 54,028 W saved

Cubical Area

70% of building is cubicles

Programmable lighting control = 15% savings

-from ASHRAE 90

Savings = 70% * 15% * 600,3166 W = 63,033 W

Energy Reduction

Overhead: 600,316 - 54,028 - 63,033 W = 483,255 W

$$\text{TOTAL:}\ 0.67\ W/ft^2 + \frac{483{,}255\ W}{274{,}200\ ft^2} = 2.43\ W/ft^2 = 15\%\ \text{reduction}$$

A Simple Approach To Lighting Automation

Ten years of leadership in lighting automation has taught us one very important lesson ... Keep It Simple!

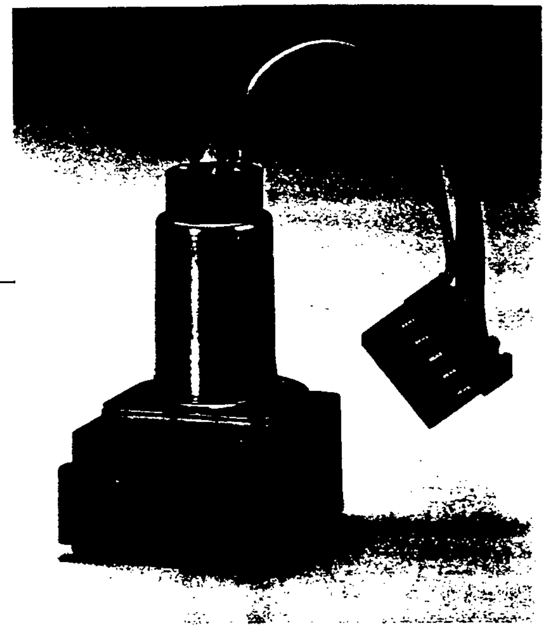
TLC does this for lighting automation by marrying a simple product concept with support services.

The Product Concept

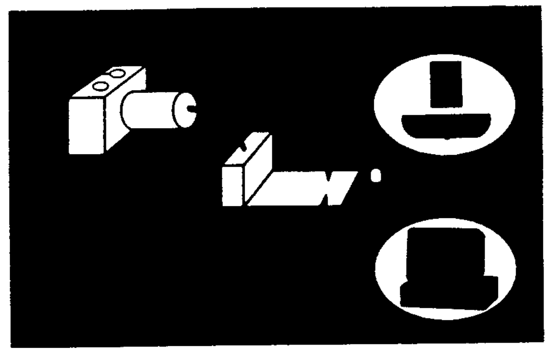
TLC uses a plug-in version of the standard 20 amp, 277 volt RR9 relay as its basic building block. These control the power to each lit space.

Each relay may be directly controlled by a low voltage switch, occupancy sensor or combination of both. This direct switching operates totally independently of any automation function. However, the relay panels will also accept plug-in intelligence cards which allow the system to be automated while still responding to direct overrides.

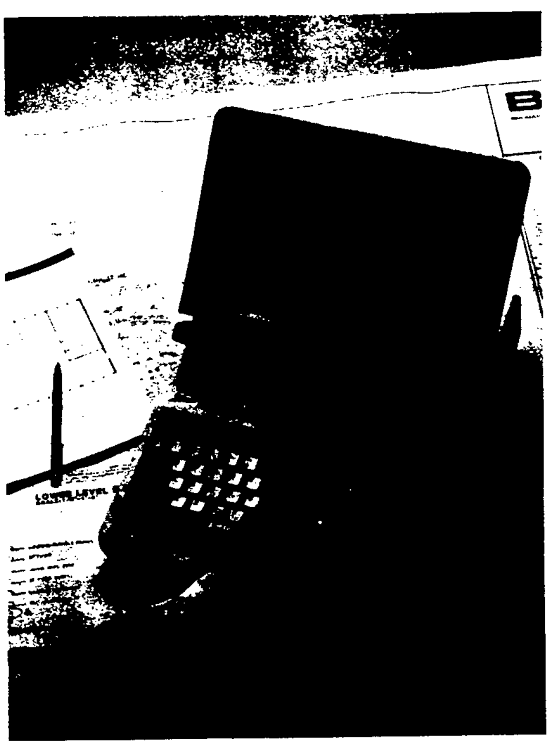
Different plug-in automation cards allow you to choose the level of automation:
- from simple timeclock control ...
- to a networked programmable lighting control system ...
- to a totally integrated intelligent building system where the lighting is integrated with HVAC, fire, security and card access.



RR9P Relay



The Support Concept



GE TLC backs up the designer, installer and owner with the personal support necessary to ensure that your design time is minimal, that the installation is trouble-free and that the system performs as expected for years to come.

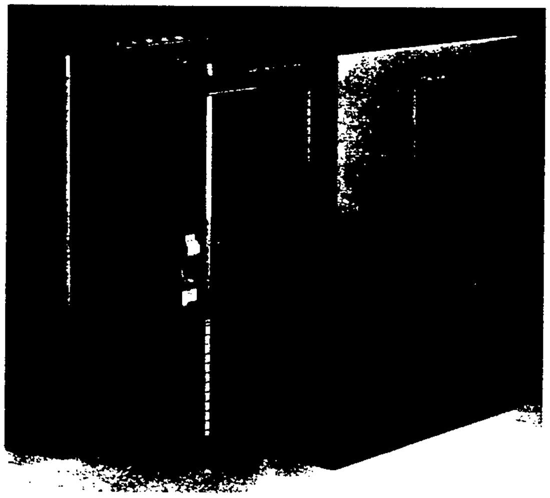
This manual explains the TLC product buildup, features and application principles. Before laying out an entire system, you may wish to ask your local TLC representative for a **TLC Options Analysis** to compare the cost/benefits of different approaches. He can also supply you with other design tools such as Typical Wiring Drawings, Guide-form Specs and Application Examples which will minimize your design time and ensure a smooth installation.

TLC Low Voltage Switching . . . The Foundation For Lighting Automation

The TLC low voltage switching (LVS) provides the foundation for a range of automation options from simple Master On/Off Control to a Programmable, Networked System. The relays used to control each lit space are provided in modular panels called Lighting Automation Panels (LAP) which mount in the electrical closet. All local switches and occupancy sensors are wired back to the panel with Class 2 wiring.

TLC uses a fully distributed control concept. The low voltage switches and occupancy sensors can continue to operate should a panel intelligence module fail. This allows the benefits of computer-based automation to co-exist with the simplicity and security of direct relay switching.

TLC Lighting Automation Panels (LAP)



Tub *Interior with Power Supply* *Cover*

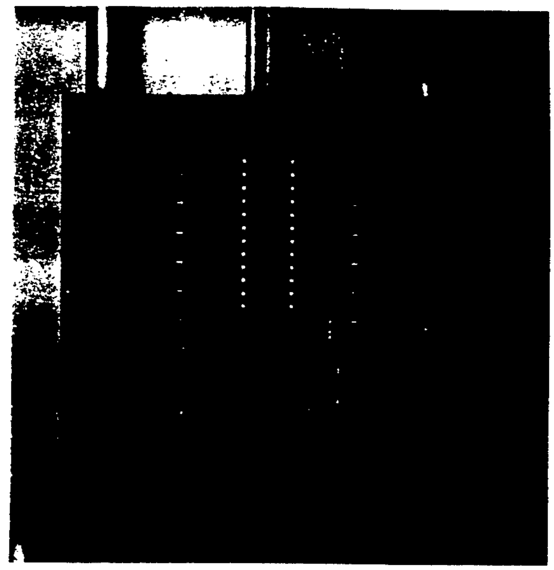
The Lighting Automation Panels are available in either a 24- or 48-relay maximum configuration. Each panel consists of a:

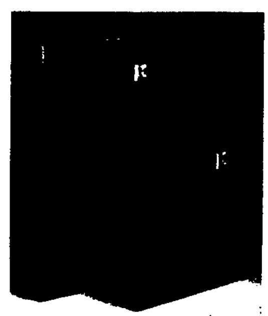
Tub
- A simple, low cost box which can be shipped to the jobsite early for rough-in wiring

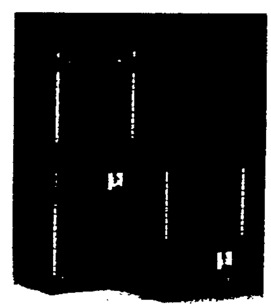
Interior
- Prewired RR9P, plug-in type relays rated at 20 amp, 277 volts (additional relays simply plug-in)
- LED status indication for each relay
- Color-coded terminations for pilot light (or standard) low voltage switches or occupancy sensors
- Expansion slots for plug-in intelligence cards

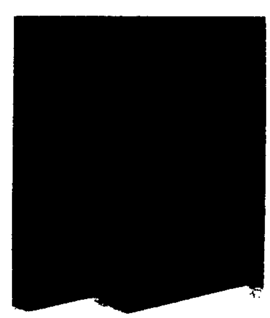
Power Supply
- Two transformers (one for the low voltage switching, the other for electronics) with internal overload protection
- GE-MOV voltage spike protection

Cover
- Standard shoebox or hinged, lockable configuration
- Wiring directory





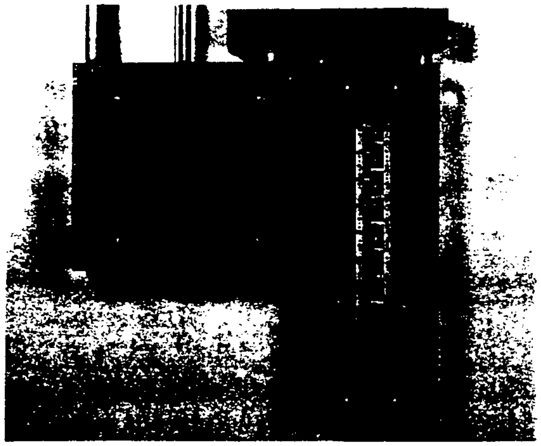




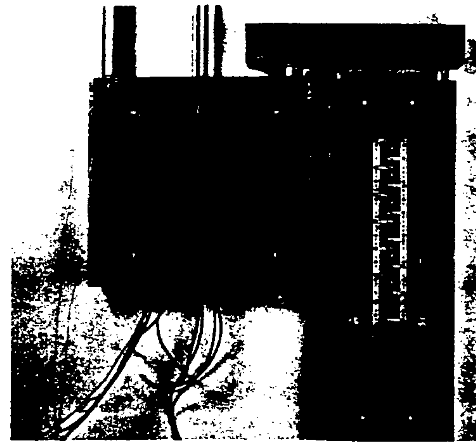
See page 24 for individual product catalog numbers and their corresponding spec (submittal) sheets. The latter provide a more detailed technical description.

TLC LAP Installation

Mount Tub



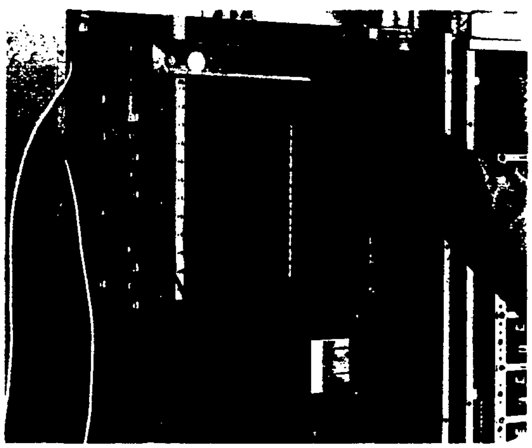
Mount the tub next to the lighting distribution panel.



Run line voltage wiring from circuit breaker to tub and switched circuits from tub to areas.

Mount Interior

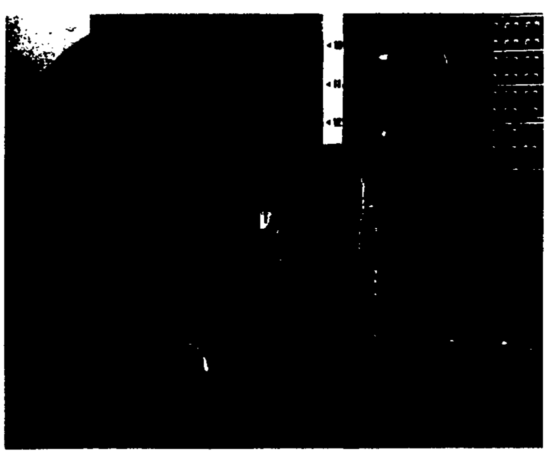
Install Power Supply



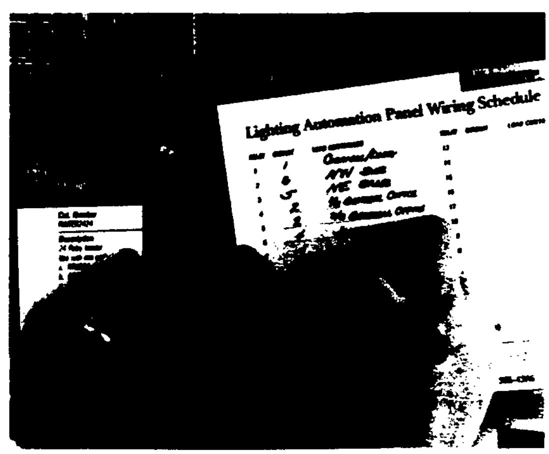
Slide the interior into the tub and secure.

Mount the power supply to the interior and plug in.

Connect Line Voltage Wiring



Connect line voltage wiring to the relays and power supply.

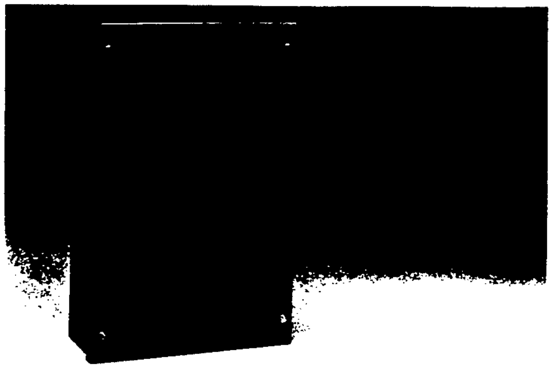


Install cover. Record all connections on the Wiring Schedule Card on the rear of the cover. Power up.

All lighting in the area is now under TLC relay control. Proceed to add direct switches and occupancy sensors.

Networked Intelligent Panels

Set panel address.



Install dataline power supply.

The controller card also supports dataline communications. The first step is to assign each panel in the system a different address (001-999) by simply setting the digits on the controller card. The dataline power supply provides communications power and a fault detection/clear function. The dataline itself is a low cost twisted pair which can be run as a single line, looped or branched. Up to 500 lighting automation panels (24,000 relays) may be installed on a single dataline.

The dataline communications network opens up a power set of system options.

Run dataline

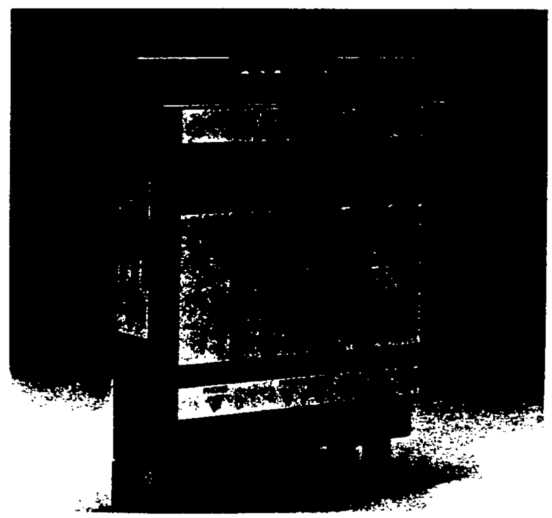
Telephone Option

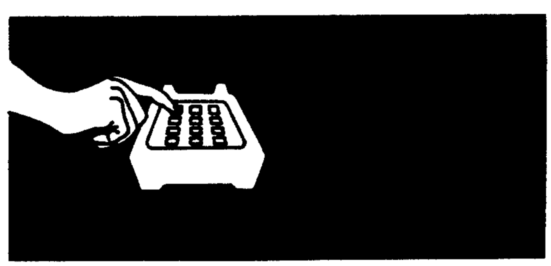
The Telephone Override Module (RPHONE) allows the existing Touchtone® phones in the building to control any relay or group of relays on the dataline. The RPHONE listens to a standard telephone extension. When a user calls the extension and enters his 4-digit ID code followed by a "1#", that code and an ON action request is transmitted over the dataline.

Individual relays which have been programmed to respond to that code will do so. The action is the same as an occupant hitting his local switch ON... the Telephone is a replacement for a local switch.

Note that the response to the telephone code is dictated by the controller's program data in each panel. This data may be entered at each panel or from a central location. Each relay in a panel can respond to up to eight different telephone codes and any number of relays may be programmed to respond to the same code.

The RPHONE includes two special function switch inputs. The first limits the phone override to "ON" only when the contact is closed. The second disables the phone override completely. When this contact is open, the RPHONE will not answer incoming calls (the telephone rings but there is no response). These two special function inputs allow the operation of the telephone to be modified for different times of the day or building occupancy.





A Simple Step

The TLC LVS that you just specified was the most time consuming part of the design process. The foundation is now in place for complete lighting automation.

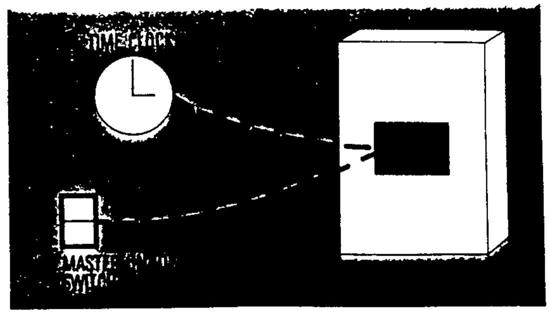
The TLC LVS design determined the number and size of lighting automation panels required by your project. These include slots for adding automation cards.

Simple Panel Master On/Off Control

The lowest level of automation simply adds a Master On/Off function to the panel.

A Master Switch or Timeclock input to the panel turns the relays on/off while still allowing the direct local switches to override their associated relays. Occupancy sensor controlled areas can be excluded from these sweeps.

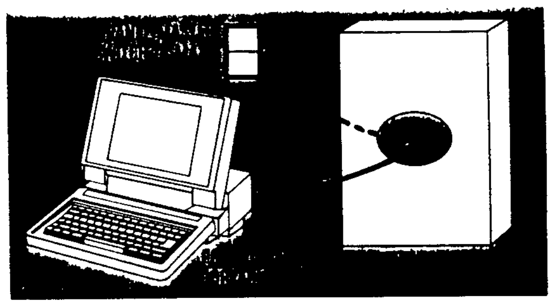
Since it's basic, we color it BLUE.



Programmable Panel Intelligence

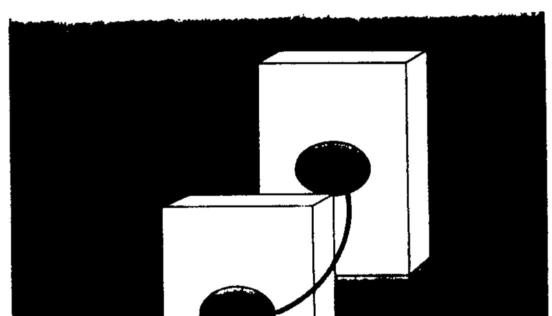
Adding programmable cards allows intelligent panel operation. Individual relays can be scheduled, programmed to "flick" warn before going off, and the direct switch can now override the automation without the lights going off first.

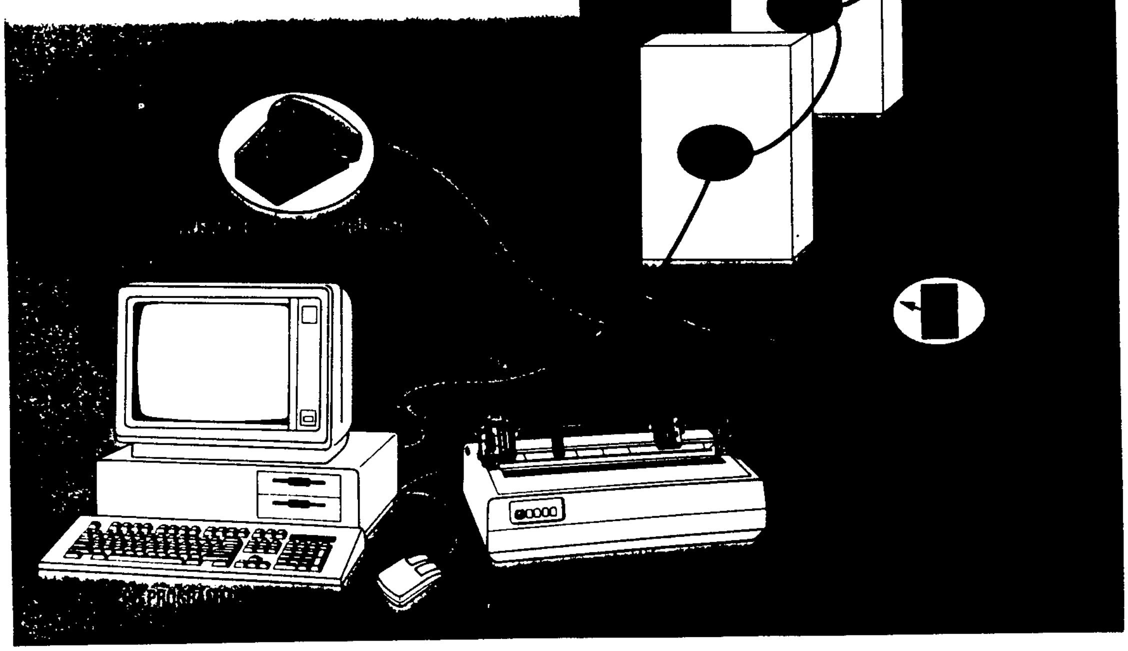
Energy savings potential increases as does sensitivity to the needs of occupants . . . color it GOLD.



Networked Intelligent Panels

The same intelligence cards that made each panel smart, also support dataline communications. This allows us to add Programmable Systemwide Switches, Telephone Control and Central Monitoring/ Programming/Control. It also allows the lighting automation system to be fully integrated into the building automation system.





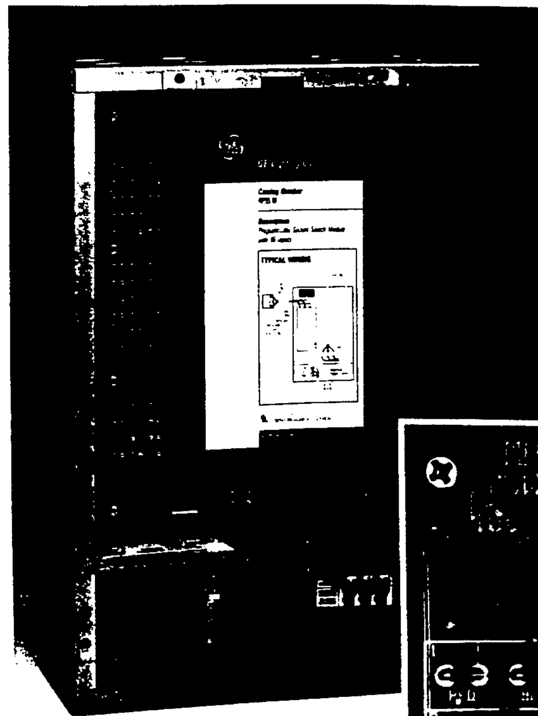
Programmable System Switches

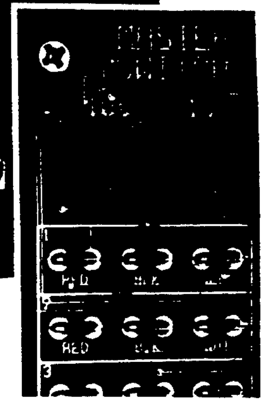
The Programmable System Switch Modules (PSS) provide systemwide intelligent switching functions. Each switch input may be programmed to control any group of relays in the system and each may be assigned one of four different operating scenarios:

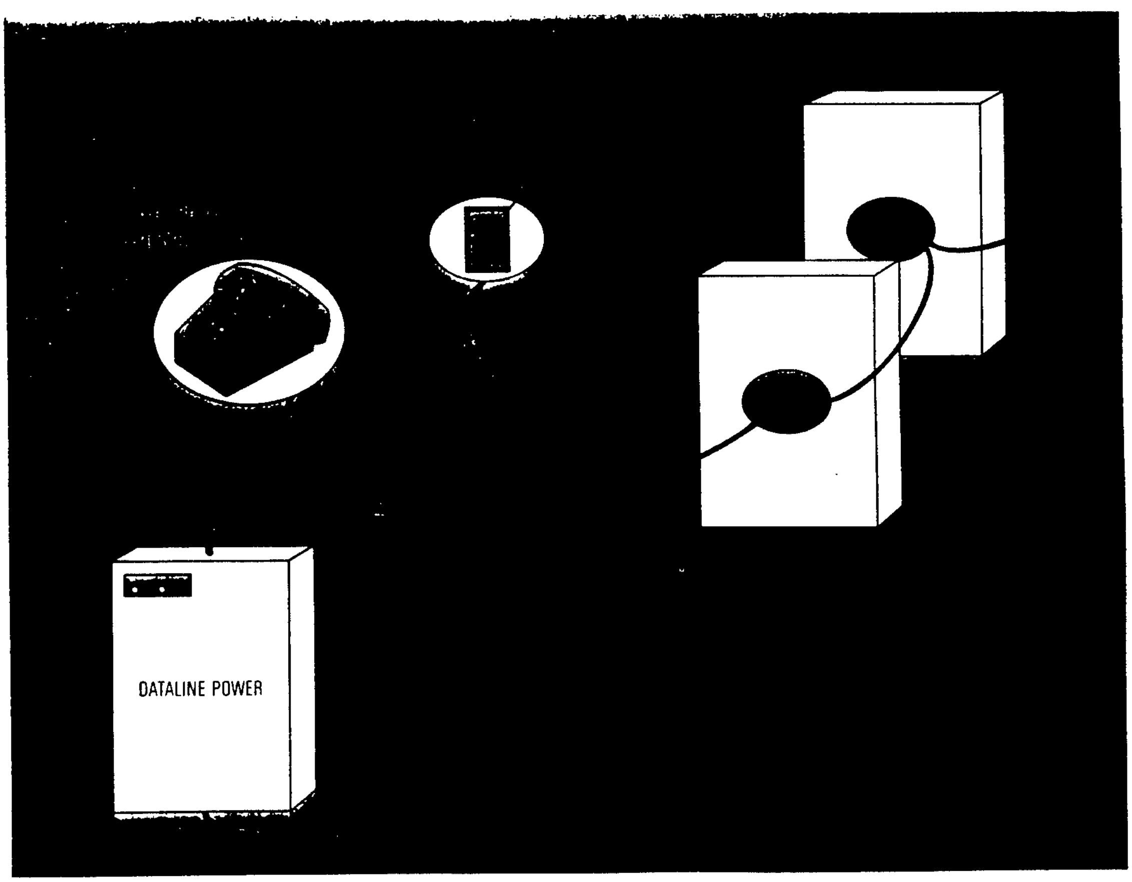
- **Master On/Off**
- **"Flick"**
- **Cleaning**
- **Shed**

A PSS input does on a systemwide basis what a Programmable Panel Switch does on a panel basis. Each PSS has a two digit address (01-99) and 16 3-wire inputs. Like the RPHONE, the PSS transmits a switch identification (address/input) and the action (on/off). The response to this message on the dataline is determined by the program data in each panel's controller. Each relay may respond to:

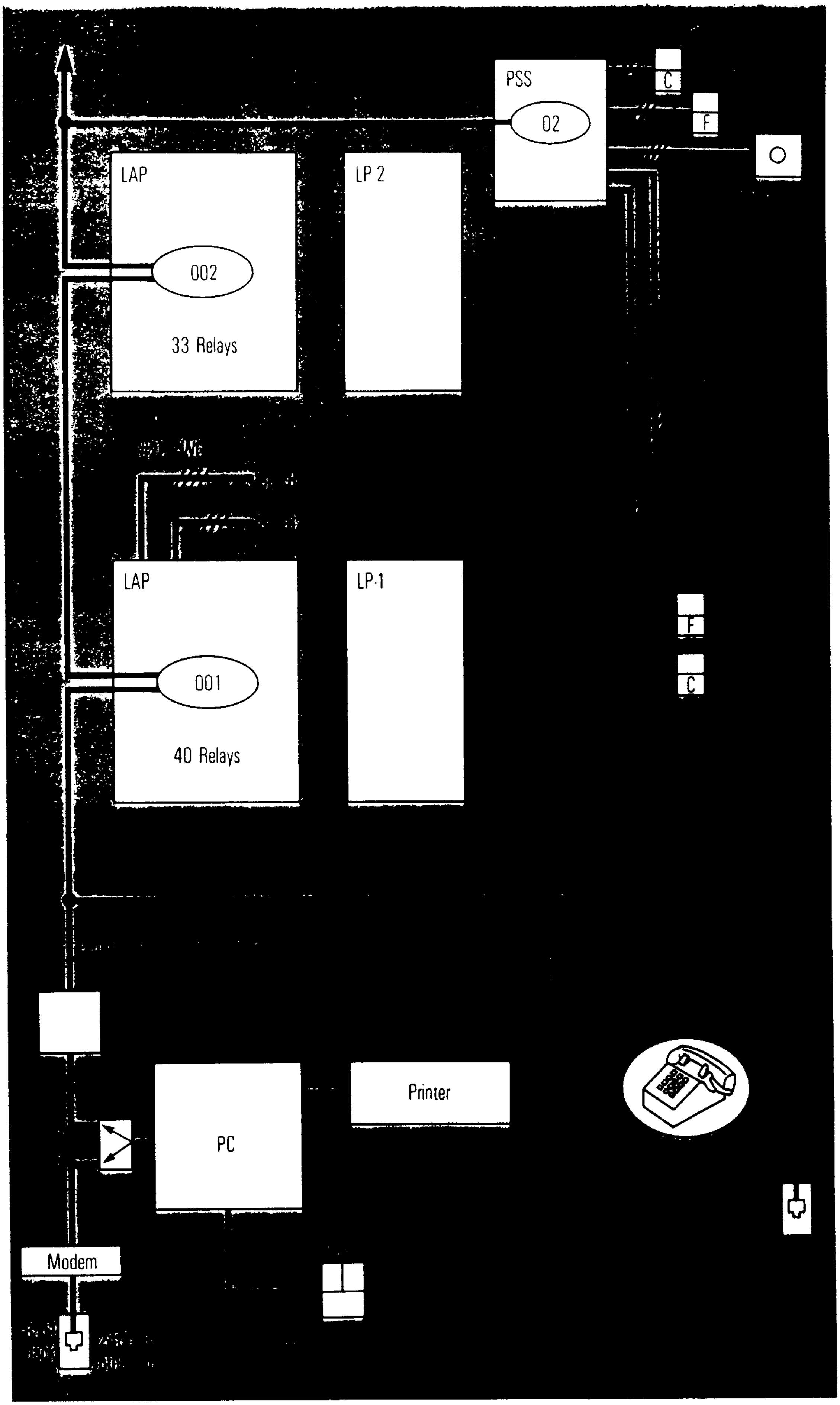
- **8 Master On/Off**
- **8 Flick**
- **4 Clean**
- **1 Shed**







Typical 1-Line



GEA-11866

GE Lighting Controls

TLC Options Analysis

C-15.1.13A

Using this form

Purpose

This Options Analysis simplifies your lighting automation design process by allowing you to quickly evaluate the relative cost and performance of different levels of lighting automation in your facility.

What you will need

The **TLC System Overview (GEA-11868)** provides all of the necessary background material required to understand the Total Lighting Control system.

You'll also need a reflected ceiling plan (or floor plan) for a typical area fed by a single electrical closet.

What you must do

1. Fill in the project identification data to the right.
2. Mark up your reflected ceiling plan as illustrated on pages 3 and 4 of this form.
3. Fill in the blanks in the highlighted areas on pages 4 and 5.
4. Return the entire completed form and your marked up reflected ceiling plan to your local GE TLC representative or send it to:

GE TLC Assistance
100 40th Place North
Birmingham, AL 35222

If you have any questions, call your local representative or 1-800-TLC-ASST.

What we will do

Provide you with an analysis for each option you selected which will include:

1. Cost of Controls Hardware
2. Feature Summary
3. Typical Guideform Spec
4. Typical 1-line
5. Typical Wiring Diagrams

Our local representative will review the analysis with you and provide further assistance.

Today's Date

Project Start Date

Project/Building Name

Street Address

City

State ZIP

Owner's Name

Address

City

State ZIP

Engineer's Name

Company

Address

City

State ZIP

Your Name

Company

Address

City

State ZIP

Telephone Number

Note: Each analysis is based on the low voltage switching configuration which you specify on your marked up reflected ceiling plan. If you wish to compare different types of switching (such as ON/OFF vs. multiple level), or if you have distinctly different areas within your building, submit a reflected ceiling plan and form for each.

C-15.1.14

Step 1 Lay Out Low Voltage Wiring

The GE TLC low voltage wiring system provides the foundation for your facility automation. Relays are used to control the power to each lit space. These are provided in pre-assembled panels which mount in the electrical closet.

Determine Relay Count

Identify each area or load that you want to independently control. Then, for each area, decide whether you want simple on/off or multiple level control. This will determine the number of relays required.

On/off control requires one relay per area. Illustration **A** to the right shows Relay 1 controlling 3-lamp fixture(s) on/off.

Typical **Multilevel** switching requires two relays as illustrated in **B.** In some applications, such as conference rooms, you may wish to use additional relays to create different lighting environments or scenes.

The **Multilevel On/Off Hi/Lo** configuration illustrated in **C** is recommended when you wish to use an occupancy sensor and still allow the occupant to select levels. It also works well with simple daylighting scenarios. The first relay controls power to the area; the other(s) select the level.

Determine Direct Overrides

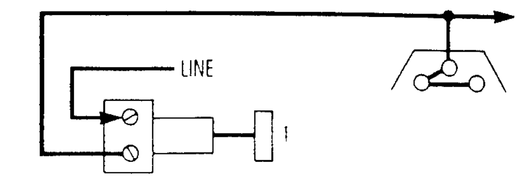
Each relay may be directly controlled by a low voltage switch, an occupancy sensor or a combination of both as shown in illustrations **D** and **E.**

The low voltage **Switches** may be either standard or pilot light type. Pilot light switches are recommended when the switched area is not visible from the switching location.

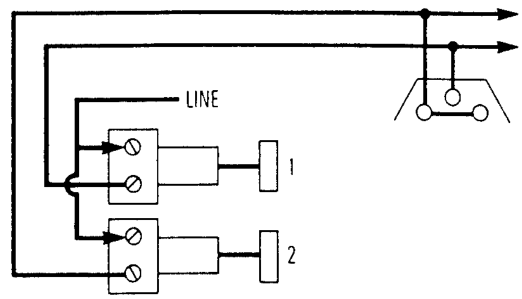
The **Occupancy Sensors** used with the GE TLC System provide coverage as follows:
One-way — 24 feet x 28 feet
Two-way — 24 feet x 56 feet
Hallway — 14 feet x 80 feet

All local switches and occupancy sensors are wired back to the relays using low voltage wiring. These wires can normally be run above the ceiling without expensive conduit. The standardized documentation makes design and installation simple.

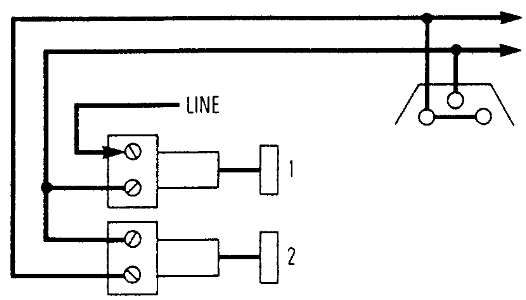
A. On/Off



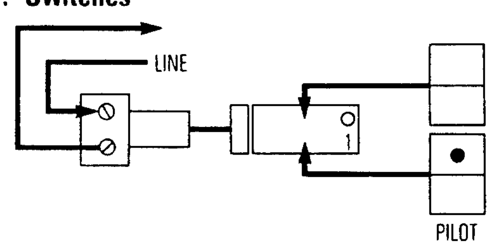
B. Multilevel (Off, 1/3, 2/3, On)



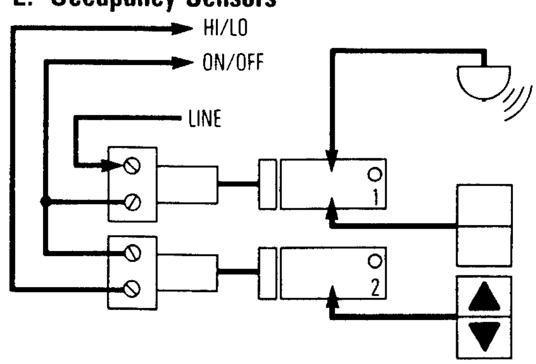
C. Multilevel On/Off Hi/Lo



D. Switches



E. Occupancy Sensors

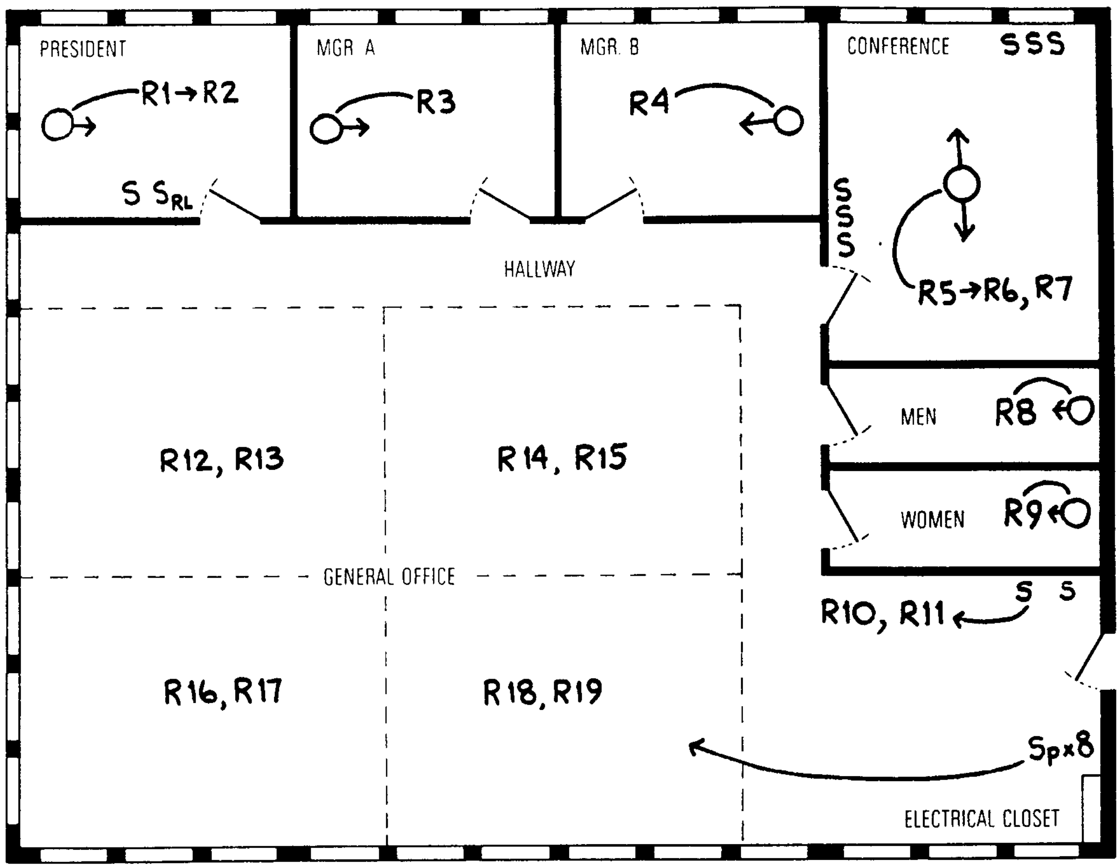


Example

Once you've determined the number of relays and the direct switching requirements, record your decisions on your reflected ceiling plan by using the symbols shown below. Then, simply number the relays sequentially from 1 to 48.

Symbols	Relay Wiring		Switches		Occupancy Sensors	
	On/Off	R__	Standard	S	One-way	—O
	Multilevel	R__, R__	Pilot Light	S_P	Two-way	—O—
	On/Off Hi/Lo	R__→R__	Hi/Lo	S_{RL}	Hallway	—Ⓗ—

Reflected Ceiling Plan showing low voltage wiring



For your typical panel location ...

1. How many relays? .... ____
2. How many standard switches? .... ____
   Pilot light switches? .... ____
3. How many 1-way occupancy sensors? .... ____
   2-way occupancy sensors? .... ____
   Hallway occupancy sensors? .... ____
4. Average low voltage switchleg length (from electrical closet to switch) in feet? .... ____
   Do they run through an air-handling plenum? ..... Yes ____ No ____

How many panel locations similar to this one? .... ____

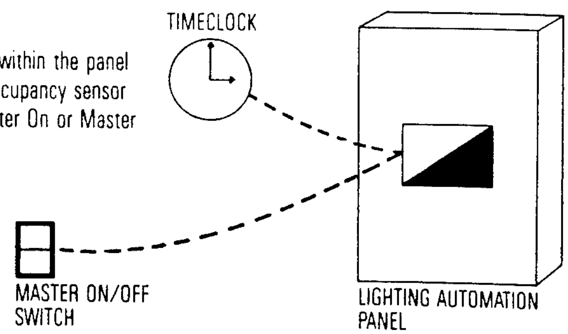
Step 2 Specify System Automation

The low voltage wiring which you just specified determined the quantity and size of the Lighting Automation Panels required for your project.

These panels provide slots for adding automation as described in the **TLC System Overview**. Simply check off the options that you wish to evaluate in the sections below.

☐ **Basic Panel Master On/Off**

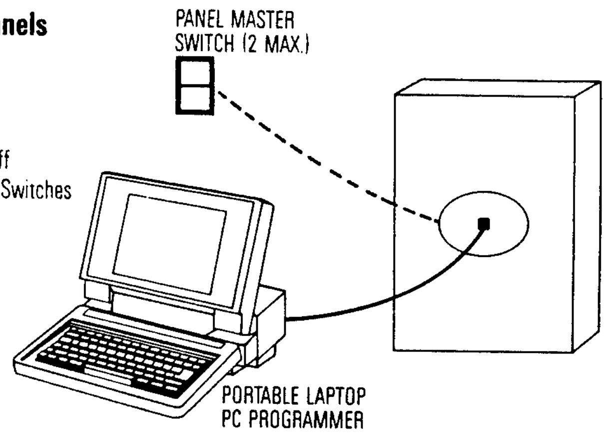
Master On/Off control of any or all relays within the panel while still allowing local switch override. Occupancy sensor areas can be excluded from either the Master On or Master Off if desired.



☐ **Programmable Intelligent Panels**

Stand-alone Operation:

- Schedule each relay
- Time Delay for overrides
- Flick Warning before scheduled Off
- Two Programmable Panel Master Switches



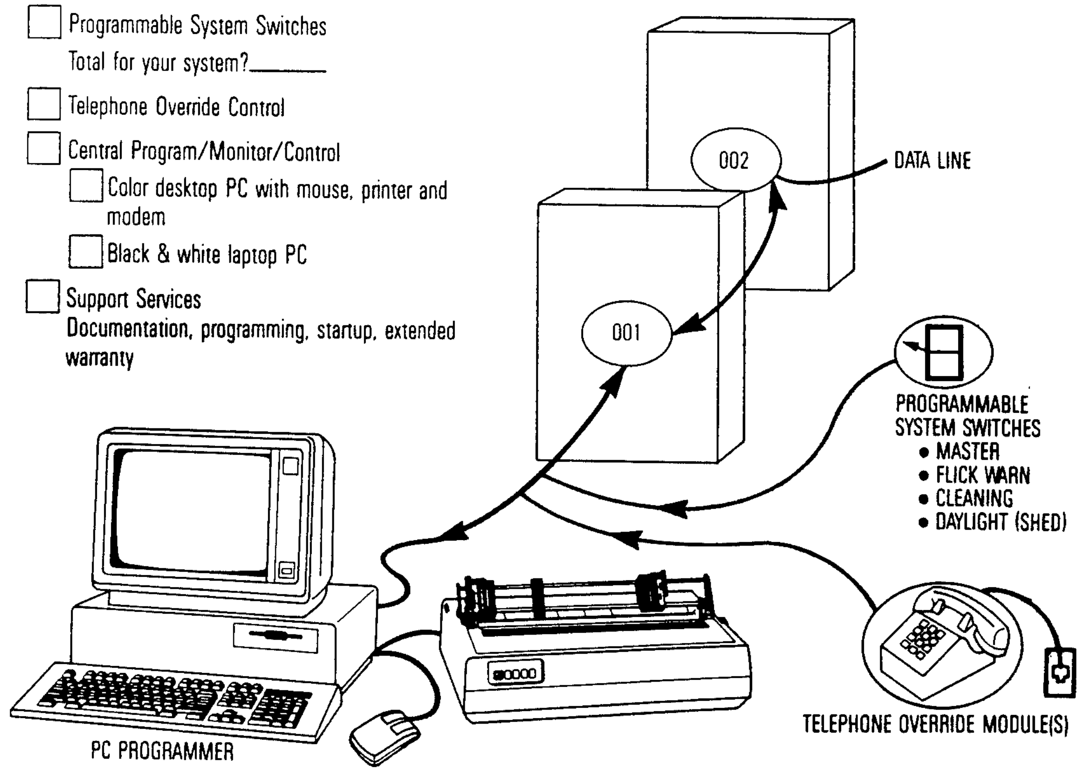
Network Options

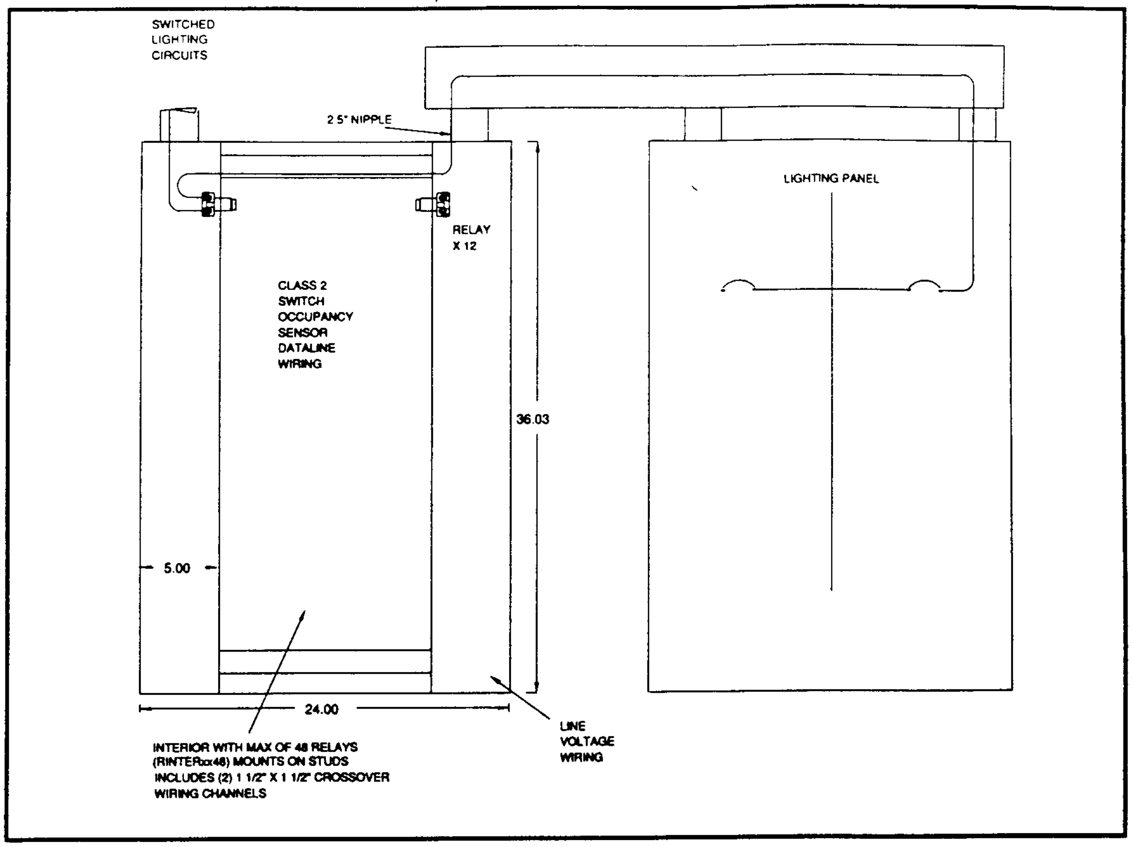
☐ Programmable System Switches
Total for your system?______

☐ Telephone Override Control

☐ Central Program/Monitor/Control
- ☐ Color desktop PC with mouse, printer and modem
- ☐ Black & white laptop PC

☐ Support Services
Documentation, programming, startup, extended warranty





ENVIRONMENT

Mount in indoor area

- *32° to 131° (0° to 50° C)*
- *10 to 95% relative humidity, non condensing*
- *15 volts/meter, 10 KHz-2GHz max RFI*
- *Stationary applications.*

MOUNTING

Orientation

- *Tub should be level, plumb, and rigidly installed with hardware sufficient to hold 100 lbs (46 kg) minimum*
- *Nameplate label should be in upper right corner.*

Flush Mount

- *Front flange should be flush with final finished surface.*

Multiple Panels

- *For surface mounting, allow a minimum of 1/4" between adjacent panels for shoebox cover clearance*
- *For flush mounting, allow a minimum of 1 3/4" (butt alignment of flush fronts) between the outside tub surfaces.*

WIRING

Line Voltage

- *Route line voltage wiring for the relays and power supply through the 2 1/2" knockouts in either the top or bottom of the tub. (You may also add holes and route through either vertical sidewall).*

Low Voltage

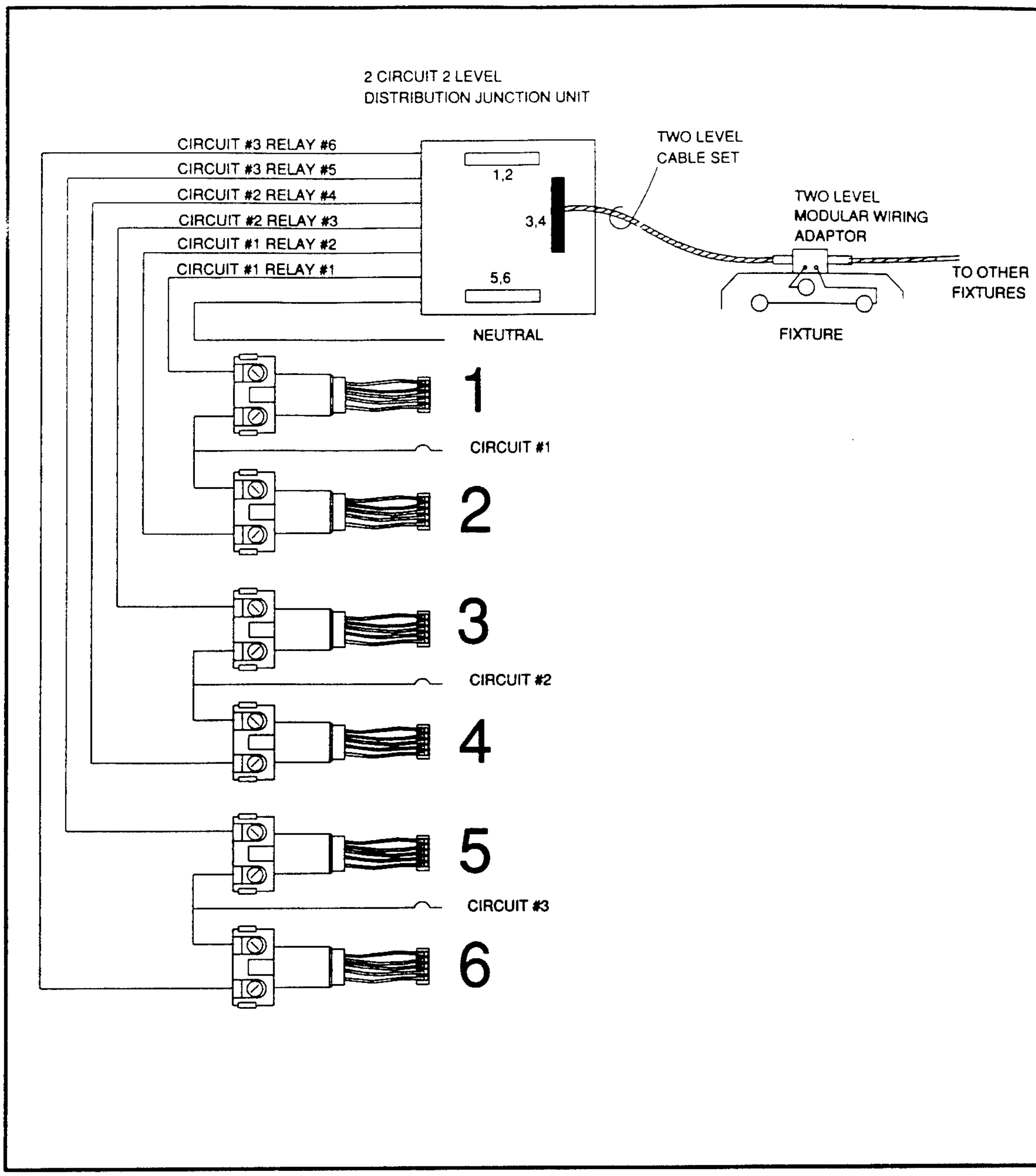
- *Route Class 2 wiring from switches and dataline (if used) through the 3/4" knockouts in either end.*

Low Voltage Switch Wire

- *Standard 20/3 Red, Black, White*
- *Pilot 20/4 Red, Black, White, Yellow*
- *Occupancy Sensor 20/4 Red, Black, White, Yelow*

CAUTION Use plenum rated (Class 2P) wire if routing through air handling plenums or risers without conduit.

- *See low voltage switch and occupancy sensor typical wiring configuration drawings for details.*

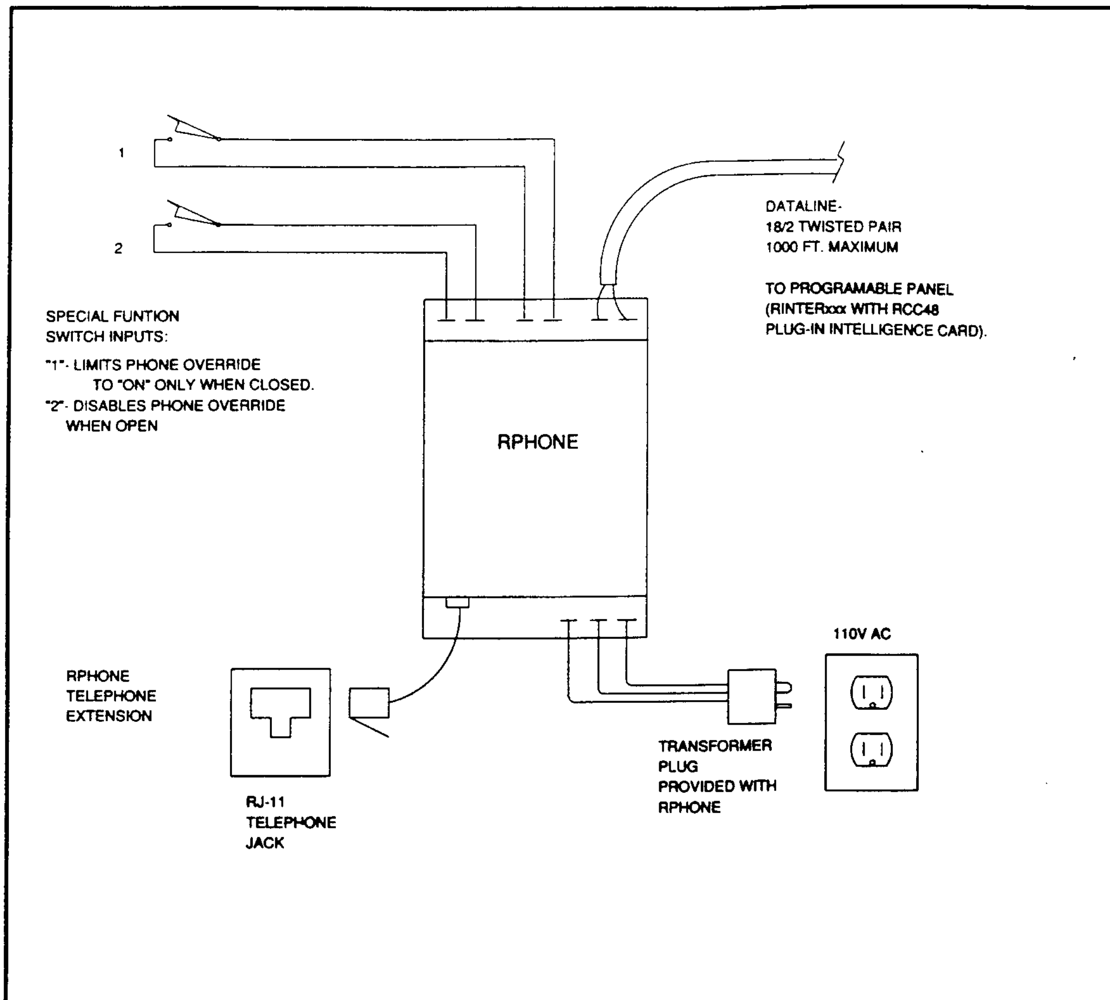


MULTILEVEL FLEX POWER WIRING

Modular or Flex wiring enhances the control flexibility of low voltage switching by allowing the fixture groups to be readily reconfigured. Low voltage switch and occupancy sensor wiring is run (normally without conduit) from the local zone back to the Lighting Automation Panel.

WIRING

- *Wire from breaker to relay per wiring schedule*
- *Route from relays to distribution junction box in the switched area. Identify all switched circuits with the relay number (1-48).*
- *Label the connectors on the junction box with the associated relay numbers.*



DESCRIPTION

Telephone Override Module

The telephone override allows any Touchtone (Dual Tone Multiple Frequency) phone to override any individual relay or group of relays. The RPHONE plugs into a standard RJ11 telephone extension.

SPECIFICATIONS

Description

Telephone Override Module

Operating Environment: *0-55 Degrees C (32-131 F)*
0-95% RH, Non Condensing
Non Corrosive atmosphere

Mounting: *Wall Mount*

CODES: *UL 916 Energy Management*

APPENDIX C-15.2

SEPARATE SWITCHES TO CONTROL LIGHTING

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: MECO25
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-15 SEPARATE SWITCHES FOR LIG
ANALYSIS DATE: 07-09-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	25267.
B. SIOH	$	1390.
C. DESIGN COST	$	1516.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	28173.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	160.	$ 1195.	15.61	18661.
B. DIST	$ .00	0.	$ 0.	21.66	0.
C. RESID	$ .00	0.	$ 0.	26.51	0.
D. NAT G	$ 4.67	-25.	$ -117.	23.77	-2775.
E. COAL	$ .00	0.	$ 0.	16.06	0.
F. TOTAL		135.	$ 1079.		$ 15885.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 1368.
(1) DISCOUNT FACTOR (TABLE A) 14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 19877.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 19877.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 5242.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) .75
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 2447.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 35762.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.27
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 11.51

SEPARATE LIGHT SWITCHES SAMPLE CALCULATION, ECO #15
BUILDING 184, ROOM 6

Given:

# of Fixtures	= 2 fixture	- from survey notes
Fixture Type	= 4x2 4-lamp fluorescent	- from survey notes
Watts / Fixture	= 155 W / fixture	- from manufacturer info
Percent Lighting Savings	= 19%	- average for all bldgs
Hours On / Year	= 3,393 hrs / yr	- from bldg occupancy
Gas Increase Factor	= 5.4E-4 MBtu / kWh	- from computer simulation
Electric Savings Factor	= 0.17 kWh / kWh	- from computer simulation
Gas Cost	= $4.67 / MBtu	- from utility rate analysis
Electric Cost	= $0.0255 / kWh	- from utility rate analysis
Demand Cost	= $8.85 / kW	- from utility rate analysis

Existing Lighting Demand:

(2 fixtures)*(155 W / fixture) = 0.31 kW

Peak Demand Savings:

(0.31 kW)*(0.19) = 0.06 kW

Annual Energy Savings:

Electric:
Lighting:
(0.06 kW)*(3,393 hrs / yr) = 200 kWh / yr
Cooling:
(200 kWh)*(0.17 kWh / kWh) = 34 kWh / yr
Total:
200 + 34 kWh / yr = 234 kWh / yr
Gas:
(200 kWh /yr)*(5.4E-4 MBtu / kWh) = 0.1 MBtu / yr

Annual Cost Savings:

(234 kWh)*($0.0255 / kWh) + (0.06 kW)*($8.85 / kW)*(4 + .95 * 8) - (0.1 MBtu)*($4.67 / MBtu) = $12.08 / yr

Estimated Construction Cost:

$65.11 / wall sensor - from engineer's cost estimate

($65.11 / ea)*(1 sensor) = $65

$65 + ($65 * .055 SIOH) + ($65 * .055 DESIGN) = $72

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 15, SEPARATE SWITCHES TO CONTROL LIGHTING

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 07/17/92
FILE: MLITSIR.WK3
PRPARED BY: CAMERAN DIBAI
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
INCREMENTAL GAS COST	$4.67 MBtu	23.77 UPWG
INCREMENTAL ELECTRIC COST	$0.0255 kWh	15.61 UPWE
ELECTRIC DEMAND CHARGE	$102.66 kW	14.53 UPW
ECONOMIC LIFE	25 YRS	
ESTIMATED 8760 HOURS OF LIGHTING PER YEAR		

BLDG	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWH)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND SAVINGS ($)	ANNUAL NON-ENER SAVINGS ($)	TOTAL ANNUAL SAVINGS ($)	CONST. COST ($)	SIR	SIMPLE PAYBACK (YRS)
41	0.85	3,415	-0.63	11	$84	$87	$0.00	$171	$1,358	1.9	7.9
101	2	7,464	-1.38	24	$184	$205	$0.00	$389	$3,401	1.7	8.7
401	0.28	1,946	-0.36	6	$48	$29	$0.00	$77	$669	1.7	8.7
246	2.1	8,407	-3.13	26	$200	$216	$0.00	$415	$4,313	1.4	10.4
170	1.45	9,446	-1.39	31	$234	$149	$0.00	$383	$4,338	1.3	11.3
366	0.076	257	-0.49	0	$4	$8	$0.00	$12	$167	1.0	13.9
171	6.57	15,922	-17.8	37	$323	$674	$0.00	$997	$13,926	1.0	14.0
TOTAL	13.326	46,857	-25.18	134.743	1077.26	1368	0	2445.3	$28,173	1.3	11.5
363	5.1	20,296	-38.5	31	$338	$524	$0.00	$861	$13,557	0.8	15.7
181	0.27	946	-0.05	3	$24	$28	$0.00	$52	$1,075	0.7	20.8
400	0.7	6,537	-1.21	21	$161	$72	$0.00	$233	$9,362	0.4	40.2
184	0.44	10,070	-4.65	30	$235	$45	$0.00	$280	$15,085	0.3	53.8
60	0.43	2,382	-4.1	4	$42	$44	$0.00	$86	$4,751	0.2	55.4
56	0	185	-0.39	0	$3	$0	$0.00	$3	$883	0.0	304.9
58	0	185	-0.39	0	$3	$0	$0.00	$3	$883	0.0	304.9
62	0	185	-0.39	0	$3	$0	$0.00	$3	$883	0.0	304.9

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

X CODE A ☐ CODE B ☐ CODE C ☐ OTHER ______

EFFECTIVE PRICING DATE APR 92

DATE PREPARED 16-Apr-92

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

DRAWING NO.

SHT OF

ESTIMATOR RMG

CHECKED BY CEL

INDIVIDUAL OFFICES: SINGLE LEVEL LIGHTING CONTROL FROM OCCUPANCY SENSORS	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
#W-120A IFRARED SENSOR	1	EA	0.25	0.25	$21.17	$5.29			$40.00	$40.00	$45.29		
SUBTOTAL						$5.29				$40.00	$45.29		
OVERHEAD, BOND	15%					$0.79				$6.00	$6.79		
PROFIT	10%					$0.53				$4.00	$4.53		
COST SUB-TOTAL						$6.62				$50.00	$56.62		
CONTINGENCY	15%					$0.99				$7.50	$8.49		
TOTAL						$7.61				$57.50	$65.11		

DA FORM 5416-R, APR 85

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

X CODE A ☐ CODE B ☐ CODE C ☐ OTHER

EFFECTIVE PRICING DATE APR 92

DATE PREPARED 16-Apr-92

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

DRAWING NO.

SHT OF

ESTIMATOR RMG

CHECKED BY CEL

INDIVIDUAL OFFICES: SINGLE LEVEL LIGHTING CONTROL FROM OCCUPANCY SENSORS	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
#W 1000A-ULTRASONIC SENSOR	1	EA	3.31	3.31	$21.17	$70.07			$85.00	$85.00	$155.07		
POWER PACK #A277D	1	EA	0.95	0.95	$21.17	$20.11			$25.00	$25.00	$45.11		
REMOVE WALL SWITCH/WIRING	1	EA	0.95	0.95	$21.17	$20.11			$8.00	$8.00	$28.11		
SENSOR WIRING/CONNECTIONS	1	EA	0.48	0.48	$21.17	$10.16			$20.00	$20.00	$30.16		
SUBTOTAL						$120				$138	$258		
OVERHEAD, BOND	15%					$18				$21	$39		
PROFIT	10%					$12				$14	$26		
COST SUB-TOTAL						$151				$173	$323		
CONTINGENCY	15%					$23				$26	$48		
TOTAL						$173				$198	$372		

DA FORM 5418-R, APR 85

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

X CODE A ☐ CODE B ☐ CODE C ☐ OTHER ______

EFFECTIVE PRICING DATE APR 92

DATE PREPARED 22-Apr-92

DRAWING NO.

SHT OF

ESTIMATOR RMG

CHECKED BY CEL

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

ELECTRICAL REWIRING FOR MULTIPLE LIGHT SWITCHING (LINE VOLTAGE)	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
ADD LIGHT SWITCH													
SWITCH AND COVERPLATE	1	EA	0.4	0.4	$21.17	$8.47			$6.45	$6.45	$14.92		
OUTLET BOX AND EXT. RING	1	EA	0.55	0.55	$21.17	$11.64			$4.65	$4.65	$16.29		
MOUNT SWITCHBOX, PATCH AND REPAIR	1	EA	3	3	$21.17	$63.51			$20.00	$20.00	$83.51		
5.5' DRYWALL, PLASTER, PAINT													
CONDUIT AND WIRE	0.2	CLF	6.15	1.23	$21.17	$26.04			$47.00	$9.40	$35.44		
CONNECTIONS AT CEILING LIGHT	1	EA	0.5	0.5	$21.17	$10.59			$3.00	$3.00	$13.59		
WIREMOLD SURFACE METAL RACEWAY	5	LF	0.8	4	$21.17	$84.68			$0.47	$2.35	$87.03		
SWITCHBOX AND SWITCH	1	EA	0.7	0.7	$21.17	$14.82			$10.00	$10.00	$24.82		
SUBTOTAL						$219.74				$55.85	$275.59		
OVERHEAD, BOND	15%					$32.96				$8.38	$41.34		
PROFIT	10%					$21.97				$5.59	$27.56		
COST SUB-TOTAL						$274.68				$69.81	$344.49		
CONTINGENCY	15%					$41.20				$10.47	$51.67		
TOTAL						$315.88				$80.28	$396.17		

DA FORM 5418-R, APR 85

TheWatt Stopper

Passive Infrared Wall Switch

- Simply replaces existing light switches
- Large 1000 sq. ft. of coverage
- Built-in light level sensor
- Adjustable Sensitivity & Time Delay
- Advanced transformer/latching relay design
- Compatible with Electronic Ballasts
- Proven 30% to 70% savings
- Available in 24VDC and 24V Half Wave
- Three-year warranty; UL Listed

System Information

The Watt Stopper WI sensors simply replace existing wall switches and turn lighting systems on only when offices, conference rooms, copy rooms or utility rooms are actually occupied. Lighting systems are automatically turned off after the controlled area is left unoccupied for a user-specified length of time. When the area is used again, the lights are automatically turned on. Savings of 30% to 70% are common.

Sensor Operation

Watt Stopper WI sensors use advanced passive infrared technology to detect occupancy. With a patented, four-level, multiple cell viewing lens, the WI sensors are able to detect the difference between the infrared emissions from a human body and the background space. When no changes in infrared energy are detected for a user specified length of time (adjustable from 30 seconds to 20 minutes), the lighting systems are switched off.

Advanced Light-Level Sensing

WI-Series sensors also offer integrated light level sensing. Simply put, if the room is unoccupied and lighting systems are OFF, WI-wall switch sensors will not turn all or part of the lighting systems ON if a user-specified level of natural light already exists. A user can simply override this feature by placing his hand over the sensor for a second. This feature will save even more energy in areas with abundant natural light.

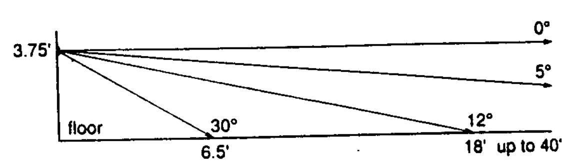
Design

WI sensors use a unique transformer and latching-relay system which allows them to work with solid state ballasts and PL lamp systems. They feature a "no-visible screws" low-profile design and an easy OFF/override. For two-gang boxes the WI sensor requires the ASP-111 for blank cover options or the ASP-112 for two level switching.

Applications and Economics

Their expansive 1000 sq. ft. of coverage, adjustable time delay, adjustable sensitivity, advanced viewing lens and built-in light level sensor make WI-series sensors highly configurable and able to handle almost any lighting situation. Due to their competitive price, low installation costs and adjustability, these sensors offer extremely fast payback rates.They are perfect for offices, utility rooms, conference rooms or any area with fluorescent or incandescent lighting systems.

The Watt Stopper, Inc.
Santa Clara, CA 95050
TEL: (408) 988-5331
FAX: (408) 988-5373
Plano, TX 75023
1-800-879-8585



WI sensors use a patented viewing lens to cover 180° with a four-level pattern which eliminates mounting height problems and insures accurate detection

WI Sensor Technical Information

WI Sensor Specifications

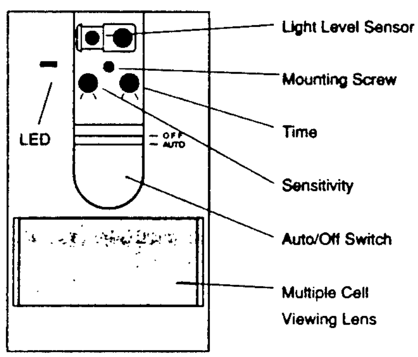
- Part of a completely integrated line of lighting control products
- Coverage: covers a 180° area — 40 foot range with adjustment
- Auto/OFF time delay adjustable from 30 seconds to 20 minutes
- Adjustable unit sensitivity
- Integrated light level sensor — works from 5 to 400 footcandles
- Red LED display to indicate detection
- Advanced transformer/latching relay design for WI-120A & WI-277A
- Works with solid-state ballasts and PL type lamps
- No leakage current in off mode — Patent Pending
- Small size — 2.8" x 4.8" x 1" (72mm x 122mm x 26mm)
- Voltage drop protection — Patent Pending
- Integrated four level fresnel lens — Patent Pending
- Three-year warranty; UL Listed
- Available in Tamper Proof Model, and in White or Ivory

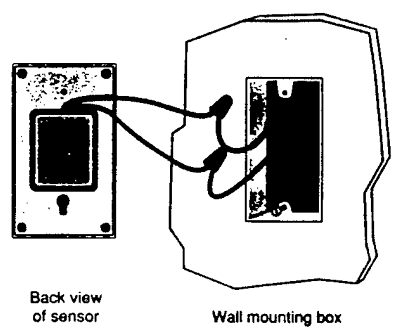
Ordering Information

Catalog No.	Coverage	Voltage	Load Requirements	Notes
WI-120A	1000 sq. ft.	120 VAC	50-600 Watts	1
WI-277A	1000 sq. ft.	277 VAC	50-1000 Watts	1
WI-24	1000 sq. ft.	24 VDC	Two 24 VDC outputs	1,2
WI-R7P	1000 sq. ft.	24 VDC halfwave	Three RR7 Relays	1,3
ASP-111	Blank plate for Two Gang Box			1
ASP-112	Switch Plate Cover-Dual Switch			1

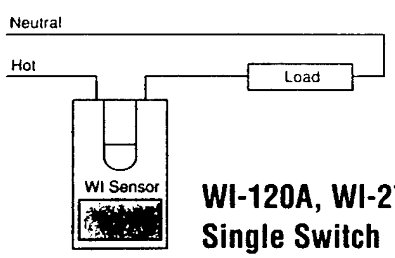
Notes: *1 – Add a **TP** to Catalog No. for Tamper Proof, and add a **W** for White or **I** for Ivory
*2 – Used with Watt Stopper Power Packs
*3 – For half-wave pulse, low-voltage lighting systems

Product Controls and Installation

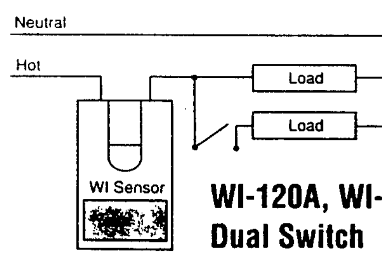




Circuit Schematics

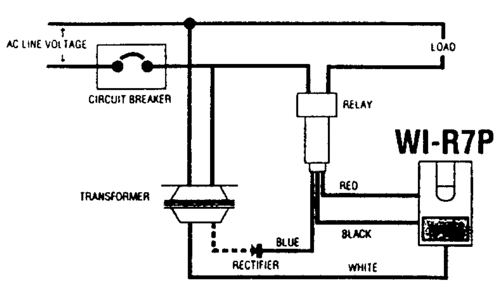


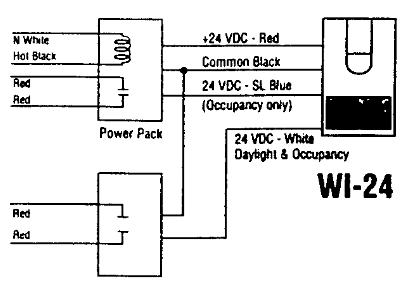
WI-120A, WI-277A Single Switch



WI-120A, WI-277A Dual Switch

(Requires ASP-112)





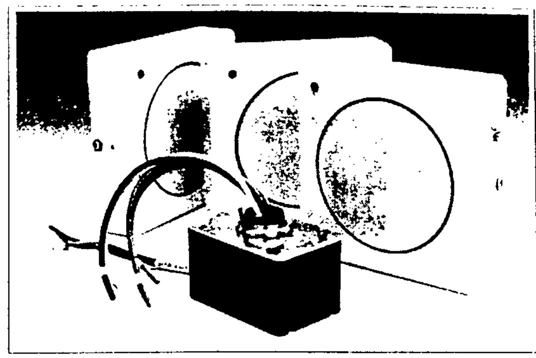
WI-24

The Watt Stopper, Inc.
Santa Clara, CA 95050
Pub. No. 0302

The Watt Stopper

Ultrasonic Sensors

- Proven 30% to 60% savings; Turn lights on only when needed
- 500, 1000 and 2000 sq. ft. coverages available
- Adjustable sensitivity & time delay
- Fully-integrated product line
- UL Listed; Three-year warranty



Complete Systems Integration

Watt Stopper Ultrasonic Sensors are part of an integrated system of lighting control products. Sensors are available to control almost any application, and can work as stand-alone products or as part of a larger lighting control system.

Operation

Watt Stopper Ultrasonic Sensors utilize advanced omni-directional ultrasonic doppler technology to sense occupancy. When ceiling mount sensors detect movement in controlled areas, they switch lighting systems on through a Watt Stopper Power Pack. The sensor controls the power pack through low-voltage wiring. As long as movement is sensed, the lights remain on. Lighting systems are switched off when no movement is detected in a user-adjustable period of time (from 15 seconds to 15 minutes).

Features

Watt Stopper Ultrasonic Sensors are designed to work across a wide variety of applications, both individually and as part of a larger system. All Watt Stopper Ultrasonic sensors feature adjustable time delay (from 15 seconds to 15 minutes), adjustable sensitivity, logic key/ON bypass and omni-directional ultrasonic technology. An LED indicator makes sensitivity adjustments easier. In addition, Watt Stopper Ultrasonic sensors are UL Listed and have a three-year warranty.

Applications

Ultrasonic sensors come in coverages of 500 sq. ft., 1000 sq. ft. and 2000 sq. ft. They're designed to work together to effectively control small offices, utility areas, open office spaces and even warehouses. The W-500A is perfect for offices, conference rooms, bathrooms and other areas up to 500 sq. ft. The W-1000A is ideal for larger spaces like classrooms and storage areas. The W-2000H is ideal for hallways, while the W-2000A is ideal for large open areas such as warehouses and can control partitioned open office spaces when configured in highly-versatile zone patterns. The W-120C and W-277C are wall switch replacement units that are ideal for small storage areas, bathrooms and enclosed rooms. All the units are designed to pick up people reaching for phones, writing, typing, etc.

Economics

Watt Stopper Ultrasonic Sensors slash utility costs by turning lights off when they're not needed. And, unlike sweep systems, they don't impair the work environment in any way. Also, easy installation and low initial cost provide fast paybacks.

- Solid State, crystal-controlled (25 KHZ± .005)
- Omni-directional transmission (360° coverage)
- Temperature and humidity-resistant 25 KHZ Microphone Receivers
- Logic Key/ON bypass
- 4.5" x 4.5" x 1.25" (115mm x 115mm x 32mm) (W x L x D)
- Available in White or Ivory

The Watt Stopper, Inc.
Santa Clara, CA 95050
TEL: (408) 988-5331
FAX: (408) 988-5373
Plano, TX 75023
1-800-879-8585

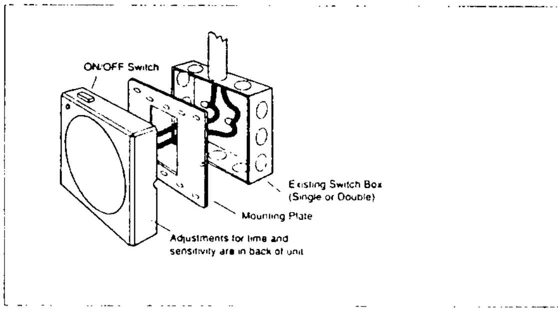
Ultrasonic Sensor Technical

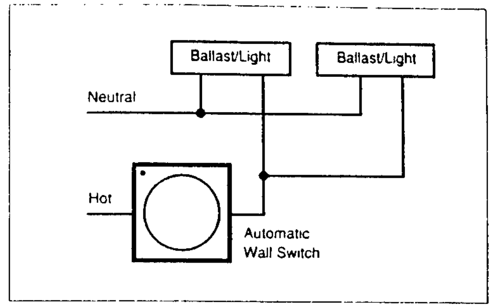
Ordering Information

Catalog No.	Description/Type	Voltage	Current/Load	Coverage	Load Requirements
W-120C	Wall Switch	120 VAC	150-800 Watts	500 sq.ft. - 180º	
W-277C	Wall Switch	277 VAC	150-1000 Watts	500 sq.ft. - 180º	
W-500A	Ceiling Sensor	24 VDC	20 ma	500 sq.ft. - 360º	1, 2*
W-1000A	Ceiling Sensor	24 VDC	20 ma	1000 sq.ft. - 360º	1, 2*
W-2000A	Ceiling Sensor	24 VDC	20 ma	2000 sq.ft. - 360º	1, 2*
W-2000H	Hallway Sensor	24 VDC	20 mA	1000 sq.ft. **	1, 2*

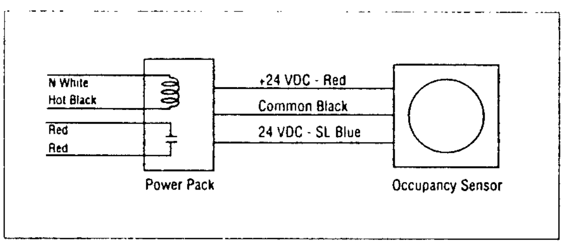
*1 - Used with Watt Stopper Power Packs.
*2 - Available for Half-wave pulse, low-voltage lighting systems. Add "-24" to Catalog No.
Note: Standard models are White, add an I to Catalog No. for Ivory.

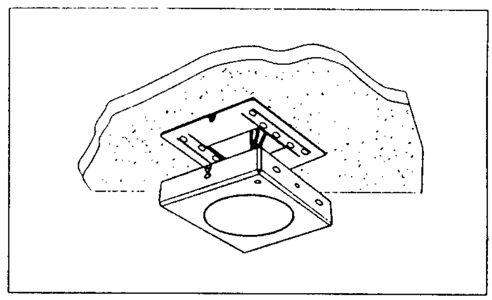
Wall Switch Placement and Schematic

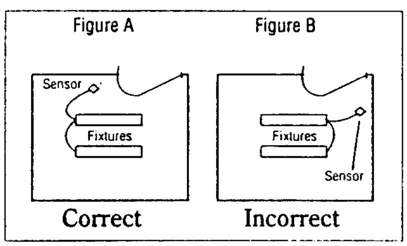




Ceiling Sensor Placement and Schematic

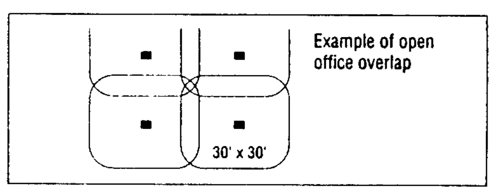




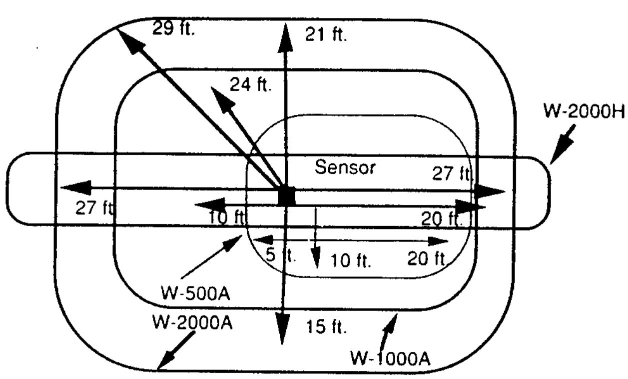


For enclosed spaces sensors should be placed as in Figure A. Sensors placed as in Figure B would see out the door, resulting in false triggering.

For standard installation use toggle bolts attaching mounting plate to ceiling tile. Always try to attach sensor to a vibration free surface.



Ceiling Sensor Coverage



For open office space the W-2000A is the most often used because of its true 360º coverage and capability to bounce off of partitions, walls, floors and other reflecting objects to sense motion. A typical layout for open office space is for the ultrasonic sensors to control the office area in zones that overlap. The coverage can be for a 20' x 20' zone and up to a maximum of 40' x 40'. A typical zone is about 25' x 25' for the lighting fixtures and an overlap on the sensor coverage that picks up to 30' x 30'.

**The W-2000H drawing is not drawn to scale. Coverage is 10' x 100' in a hallway, walls are

The Watt Stopper, Inc.
Santa Clara, CA 95050
Pub. N° ?102

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 21-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 41LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 4

BUILDING NUMBER: 41

Sheet 1 of 1

Schedule #1	M-F	600 to	1900	S-S	0 to	0		
Schedule #2	M-F	0 to	0	S-S	0 to	0		

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
1	2	4x2-4 lamp fluorescent	off	yes	yes	2	no
2	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
3	4	4x2-4 lamp fluorescent	on	yes	no	1	no
4	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
5	4	4x2-4 lamp fluorescent	on	yes	yes	2	no
6	5	4x2-2 lamp fluorescent	on	yes	no	2	no
7	2	4x2-4 lamp fluorescent	on	yes	no	1	no
8	6	4x2-4 lamp fluorescent	off	yes	no	1	no
9	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
10	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
11	1	4x2-4 lamp fluorescent	on	yes	no	2	no
12	20	4x2-4 lamp fluorescent	off	yes	no	2	no
13	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
14	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
15	1	4x2-2 lamp fluorescent	on	yes	yes	1	no
16	1	4x2-2 lamp fluorescent	on	yes	yes	1	no
17	1	4x2-2 lamp fluorescent	off	yes	yes	1	no
18	4	4x2-4 lamp fluorescent	off	yes	no	1	no
19	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
20	4	4x2-4 lamp fluorescent	on	yes	no	1	no
21	6	4x2-4 lamp fluorescent	on	yes	no	1	no
22	3	4x2-2 lamp fluorescent	on	yes	no	1	no
23	5	4x2-4 lamp fluorescent	on	yes	no	2	no
24	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
25	2	4x2-4 lamp fluorescent	off	yes	yes	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 21-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 41LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 41

Sheet 1 of 1

% Unnoc. lights: 19%
Gas Increase Factor 2.20E-04 MBtu/kWh
Cooling Factor (Energy) 1.19

Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches: No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
1	0.31	3393	0.06	200	0.044	238	0	$0.00	YES	$65.11	NO	$0.00
2	0.31	3393	0.06	200	0.044	238	0	$0.00	YES	$65.11	NO	$0.00
3	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
4	0.47	3393	0.09	300	0.066	357	0	$0.00	YES	$65.11	NO	$0.00
5	0.62	3393	0.12	400	0.088	476	0	$0.00	NO	$0.00	YES	$372.00
6	0.45	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
7	0.31	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
8	0.93	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
9	0.31	3393	0.06	200	0.044	238	0	$0.00	YES	$65.11	NO	$0.00
10	0.31	3393	0.06	200	0.044	238	0	$0.00	YES	$65.11	NO	$0.00
11	0.16	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
12	3.10	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
13	0.47	3393	0.09	300	0.066	357	0	$0.00	YES	$65.11	NO	$0.00
14	0.47	3393	0.09	300	0.066	357	0	$0.00	YES	$65.11	NO	$0.00
15	0.09	3393	0.02	57	0.013	68	0	$0.00	YES	$65.11	NO	$0.00
16	0.09	3393	0.02	57	0.013	68	0	$0.00	YES	$65.11	NO	$0.00
17	0.09	3393	0.02	57	0.013	68	0	$0.00	YES	$65.11	NO	$0.00
18	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
19	0.31	3393	0.06	200	0.044	238	0	$0.00	YES	$65.11	NO	$0.00
20	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
21	0.93	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
22	0.27	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
23	0.78	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
24	0.31	3393	0.06	200	0.044	238	0	$0.00	YES	$65.11	NO	$0.00
25	0.31	3393	0.06	200	0.044	238	0	$0.00	YES	$65.11	NO	$0.00
Total	13.224		0.84588	2870.071	0.63142	3415.384	0	$0.00		$846.43		$372.00

Total $ Expense = $1,218.43

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 21-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 58LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 12

BUILDING NUMBER: 58

Schedule #1 M-F 700 to 1900 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
121	2	4x2-2 lamp fluorescent	off	yes	no	1	no
122	2	4x2-2 lamp fluorescent	off	yes	no	1	no
123	2	4x2-2 lamp fluorescent	off	yes	no	1	no
124	2	4x2-2 lamp fluorescent	off	yes	no	1	no
125	2	4x2-2 lamp fluorescent	off	yes	no	1	no
126	2	4x2-2 lamp fluorescent	off	yes	no	1	no
127	2	4x2-2 lamp fluorescent	off	yes	no	1	no
128	2	4x2-2 lamp fluorescent	off	yes	no	1	no
HALL-1	8	4x2-2 lamp fluorescent	on	yes	no	1	no
HALL-2	4	4x2-2 lamp fluorescent	on	yes	no	2	no
HALL-3	8	4x2-2 lamp fluorescent	on	yes	no	1	no
MEN'S-1	6	4x2-2 lamp fluorescent	on	yes	no	1	no
131	2	4x2-2 lamp fluorescent	on	yes	no	1	no
132	2	4x2-2 lamp fluorescent	on	yes	no	1	no
133	2	4x2-2 lamp fluorescent	on	yes	no	1	no
134	2	4x2-2 lamp fluorescent	on	yes	no	1	no
135	2	4x2-2 lamp fluorescent	on	yes	no	1	no
136	2	4x2-2 lamp fluorescent	on	yes	no	1	no
137	2	4x2-2 lamp fluorescent	on	yes	no	1	no
138	2	4x2-2 lamp fluorescent	on	yes	no	1	no
139	2	4x2-2 lamp fluorescent	on	yes	no	1	no
121	2	4x2-2 lamp fluorescent	off	yes	no	1	no
122	2	4x2-2 lamp fluorescent	off	yes	no	1	no
123	2	4x2-2 lamp fluorescent	off	yes	no	1	no
124	2	4x2-2 lamp fluorescent	off	yes	no	1	no
125	2	4x2-2 lamp fluorescent	off	yes	no	1	no
126	2	4x2-2 lamp fluorescent	off	yes	no	1	no
127	2	4x2-2 lamp fluorescent	off	yes	no	1	no
128	2	4x2-2 lamp fluorescent	off	yes	no	1	no
131	2	4x2-2 lamp fluorescent	off	yes	no	1	no
132	2	4x2-2 lamp fluorescent	off	yes	no	1	no
133	2	4x2-2 lamp fluorescent	off	yes	no	1	no
134	2	4x2-2 lamp fluorescent	off	yes	no	1	no
135	2	4x2-2 lamp fluorescent	off	yes	no	1	no
136	2	4x2-2 lamp fluorescent	off	yes	no	1	no
137	2	4x2-2 lamp fluorescent	off	yes	no	1	no
138	2	4x2-2 lamp fluorescent	off	yes	no	1	no
139	2	4x2-2 lamp fluorescent	off	yes	no	1	no
HALL-4	4	4x2-2 lamp fluorescent	on	no	no	0	no
HALL-5	8	4x2-2 lamp fluorescent	on	no	no	0	no
221	2	4x2-2 lamp fluorescent	off	yes	no	1	no
222	2	4x2-2 lamp fluorescent	off	yes	no	1	no
223	2	4x2-2 lamp fluorescent	off	yes	no	1	no
224	2	4x2-2 lamp fluorescent	off	yes	no	1	no
225	2	4x2-2 lamp fluorescent	off	yes	no	1	no
226	2	4x2-2 lamp fluorescent	off	yes	no	1	no
227	2	4x2-2 lamp fluorescent	off	yes	no	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION:

EMC PROJECT: #3105.000
DATE: 21-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 58LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 58

Schedule #1 M-F 700 to 1900 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Lights	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
228	2	4x2-2 lamp fluorescent	off	yes	no	1	no
229	2	4x2-2 lamp fluorescent	off	yes	no	1	no
HALL-6	8	4x2-2 lamp fluorescent	on	yes	no	1	no
231	2	4x2-2 lamp fluorescent	off	yes	no	1	no
232	2	4x2-2 lamp fluorescent	off	yes	no	1	no
233	2	4x2-2 lamp fluorescent	off	yes	no	1	no
234	2	4x2-2 lamp fluorescent	off	yes	no	1	no
235	2	4x2-2 lamp fluorescent	off	yes	no	1	no
236	2	4x2-2 lamp fluorescent	off	yes	no	1	no
237	2	4x2-2 lamp fluorescent	off	yes	no	1	no
MEN'S-2	26	4x2-2 lamp fluorescent	on	yes	no	5	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 21-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 58LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 58

Sheet 1 of 2

% Unnoc. lights: 19%
Gas Increase Factor 2.10E-03 MBtu/kWh
Cooling Factor (Energy) 1.22

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
121	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
122	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
123	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
124	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
125	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
126	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
127	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
128	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
HALL-1	0.71	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
HALL-2	0.36	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
HALL-3	0.71	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
MEN'S-	0.53	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
131	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
132	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
133	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
134	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
135	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
136	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
137	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
138	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
139	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
121	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
122	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
123	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
124	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
125	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
126	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
127	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
128	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
131	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
132	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
133	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
134	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
135	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
136	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
137	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
138	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
139	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
HALL-4	0.36	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
HALL-5	0.71	3132	0.00	185	0.389	226	2	$792.34	NO	$0.00	NO	$0.00
221	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
222	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
223	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
224	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
225	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
226	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
227	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
				185.12						$0.00		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

EMC PROJECT: #3105.000
DATE: 21-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 58LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 58

Sheet 2 of 2

% Unnoc. lights: 19%
Gas Increase Factor 2.10E-03 MBtu/kWh
Cooling Factor (Energy) 1.22

Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu/yr)	Total kWh Saved/Yr	Cost of Switches: No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
228	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
229	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
HALL-6	0.71	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
231	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
232	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
233	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
234	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
235	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
236	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
237	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
MEN'S-	2.31	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
Total	15.308		0	185.12	0.38875	225.8464	2	$792.34		$0.00		$0.00
				Total $ Expense =		$792.34						

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 60LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 17

BUILDING NUMBER: 60

Sheet 1 of 3

Schedule #1	M-F	700 to	2200	S-S	0 to	2400
Schedule #2	M-F	0 to	0	S-S	0 to	0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
21	1	4x2-2 lamp fluorescent	on	no	no	0	no
21	1	4' Single lamp fluorescent	on	no	no	0	no
22	5	4x2-2 lamp fluorescent	on	yes	yes	5	no
22	5	4' Single lamp fluorescent	on	no	yes	0	no
214	1	4x2-2 lamp fluorescent	off	yes	no	1	no
214	1	4' Single lamp fluorescent	off	yes	no	1	no
216	1	4x2-2 lamp fluorescent	off	yes	no	1	no
216	1	4' Single lamp fluorescent	off	yes	no	1	no
217	1	4x2-2 lamp fluorescent	off	yes	no	1	no
217	1	4' Single lamp fluorescent	off	yes	no	1	no
219	1	4x2-2 lamp fluorescent	off	yes	no	1	no
219	1	4' Single lamp fluorescent	off	yes	no	1	no
220	1	4x2-2 lamp fluorescent	off	yes	no	1	no
220	1	4' Single lamp fluorescent	off	yes	no	1	no
218	1	4x2-2 lamp fluorescent	off	yes	no	1	no
218	1	4' Single lamp fluorescent	off	yes	no	1	no
215	1	4x2-2 lamp fluorescent	off	yes	no	1	no
215	1	4' Single lamp fluorescent	off	yes	no	1	no
2	2	4x2-2 lamp fluorescent	on	no	no	0	no
3	3	4' Single lamp fluorescent	on	yes	no	1	no
4	3	4' Single lamp fluorescent	on	yes	no	1	no
116	1	4x2-2 lamp fluorescent	off	yes	no	1	no
116	1	4' Single lamp fluorescent	off	yes	no	1	no
118	1	4x2-2 lamp fluorescent	off	yes	no	1	no
118	1	4' Single lamp fluorescent	off	yes	no	1	no
117	1	4x2-2 lamp fluorescent	off	yes	no	1	no
117	1	4' Single lamp fluorescent	off	yes	no	1	no
120	1	4x2-2 lamp fluorescent	off	yes	no	1	no
120	1	4' Single lamp fluorescent	off	yes	no	1	no
122	1	4x2-2 lamp fluorescent	off	yes	no	1	no
122	1	4' Single lamp fluorescent	off	yes	no	1	no
121	1	4x2-2 lamp fluorescent	off	yes	no	1	no
121	1	4' Single lamp fluorescent	off	yes	no	1	no
119	1	4x2-2 lamp fluorescent	off	yes	no	1	no
119	1	4' Single lamp fluorescent	off	yes	no	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION:

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 60LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 60

Sheet 2 of 3

Schedule #1 M-F 700 to 2200 S-S 0 to 2400
Schedule #2 M-F 0 to 0 S-S 0 to 0

NOTE: ALL ROOM LIGHT NUMBERS ON THIS SHEET ARE DOUBLED TO ACCOUNT FOR IDENTICAL WEST WING.

Room No.	# of Lights	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
5	2	4x2-2 lamp fluorescent	off	yes	no	1	no
5	2	4' Single lamp fluorescent	off	yes	no	1	no
6	2	4x2-2 lamp fluorescent	off	yes	no	1	no
6	2	4' Single lamp fluorescent	off	yes	no	1	no
7	2	4x2-2 lamp fluorescent	off	yes	no	1	no
7	2	4' Single lamp fluorescent	off	yes	no	1	no
8	2	4x2-2 lamp fluorescent	off	yes	no	1	no
8	2	4' Single lamp fluorescent	off	yes	no	1	no
9	2	4x2-2 lamp fluorescent	off	yes	no	1	no
9	2	4' Single lamp fluorescent	off	yes	no	1	no
10	2	4x2-2 lamp fluorescent	off	yes	no	1	no
10	2	4' Single lamp fluorescent	off	yes	no	1	no
11	2	4x2-2 lamp fluorescent	off	yes	no	1	no
11	2	4' Single lamp fluorescent	off	yes	no	1	no
12	2	4x2-2 lamp fluorescent	off	yes	no	1	no
12	2	4' Single lamp fluorescent	off	yes	no	1	no
13	2	4x2-2 lamp fluorescent	off	yes	no	1	no
13	2	4' Single lamp fluorescent	off	yes	no	1	no
17	2	4x2-2 lamp fluorescent	off	yes	no	1	no
17	2	4' Single lamp fluorescent	off	yes	no	1	no
18	2	4x2-2 lamp fluorescent	off	yes	no	1	no
18	2	4' Single lamp fluorescent	off	yes	no	1	no
19	2	4x2-2 lamp fluorescent	off	yes	no	1	no
19	2	4' Single lamp fluorescent	off	yes	no	1	no
20	2	4x2-2 lamp fluorescent	off	yes	no	1	no
20	2	4' Single lamp fluorescent	off	yes	no	1	no
14	2	4x2-2 lamp fluorescent	off	yes	no	1	no
14	2	4' Single lamp fluorescent	off	yes	no	1	no
15	2	4x2-2 lamp fluorescent	off	yes	no	1	no
15	2	4' Single lamp fluorescent	off	yes	no	1	no
16	2	4x2-2 lamp fluorescent	off	yes	no	1	no
16	2	4' Single lamp fluorescent	off	yes	no	1	no
23	2	4x2-2 lamp fluorescent	off	yes	no	1	no
23	2	4' Single lamp fluorescent	off	yes	no	1	no
24	2	4x2-2 lamp fluorescent	off	yes	no	1	no
24	2	4' Single lamp fluorescent	off	yes	no	1	no
25	2	4x2-2 lamp fluorescent	off	yes	no	1	no
25	2	4' Single lamp fluorescent	off	yes	no	1	no
26	2	4x2-2 lamp fluorescent	off	yes	no	1	no
26	2	4' Single lamp fluorescent	off	yes	no	1	no
27	2	4x2-2 lamp fluorescent	off	yes	no	1	no
27	2	4' Single lamp fluorescent	off	yes	no	1	no
28	2	4x2-2 lamp fluorescent	off	yes	no	1	no
28	2	4' Single lamp fluorescent	off	yes	no	1	no
29	2	4x2-2 lamp fluorescent	off	yes	no	1	no
29	2	4' Single lamp fluorescent	off	yes	no	1	no
30	2	4x2-2 lamp fluorescent	off	yes	no	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION:

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 60LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 60

Schedule #1 M-F 700 to 2200 S-S 0 to 2400
Schedule #2 M-F 0 to 0 S-S 0 to 0

NOTE: ALL ROOM LIGHT NUMBERS ON THIS SHEET ARE DOUBLED TO ACCOUNT FOR IDENTICAL WEST WING.

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
30	2	4' Single lamp fluorescent	off	yes	no	1	no
31	2	4x2-2 lamp fluorescent	off	yes	no	1	no
31	2	4' Single lamp fluorescent	off	yes	no	1	no
32	4	4x2-2 lamp fluorescent	off	yes	no	1	no
32	4	4' Single lamp fluorescent	off	yes	no	1	no
33	4	4x2-2 lamp fluorescent	off	yes	no	1	no
33	4	4' Single lamp fluorescent	off	yes	no	1	no
34	2	4x2-2 lamp fluorescent	off	yes	no	1	no
34	2	4' Single lamp fluorescent	off	yes	no	1	no
35	2	4x2-2 lamp fluorescent	off	yes	no	1	no
35	2	4' Single lamp fluorescent	off	yes	no	1	no
36	10	4x2-2 lamp fluorescent	on	yes	yes	5	yes
36	16	4' Single lamp fluorescent	on	yes	yes	1	yes
37	8	4' Single lamp fluorescent	on	yes	no	1	no
37	6	4x2-2 lamp fluorescent	on	yes	no	1	no
38	8	4' Single lamp fluorescent	on	yes	no	1	no
38	2	4' Single lamp fluorescent	off	yes	no	1	no
Corr-1	16	4x2-2 lamp fluorescent	on	yes	no	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 60LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 60

% Unnoc. lights: 19%
Gas Increase Factor 2.10E-03 MBtu/kWh
Cooling Factor (Energy) 1.22

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
21	0.09	6411	0.00	23	0.049	28	1	$396.17	NO	$0.00	NO	$0.00
21	0.05	6411	0.00	12	0.025	14	1	$396.17	NO	$0.00	NO	$0.00
22	0.45	6411	0.08	542	1.138	661	0	$0.00	NO	$0.00	YES	$372.00
22	0.23	6411	0.04	59	0.123	71	1	$396.17	NO	$0.00	YES	$372.00
214	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
214	0.05	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
216	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
216	0.05	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
217	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
217	0.05	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
219	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
219	0.05	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
220	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
220	0.05	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
218	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
218	0.05	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
215	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
215	0.05	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
2	0.18	6411	0.00	46	0.097	56	1	$396.17	NO	$0.00	NO	$0.00
3	0.14	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
4	0.14	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
116	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
116	0.05	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
118	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
118	0.05	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
117	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
117	0.05	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
120	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
120	0.05	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
122	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
122	0.05	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
121	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
121	0.05	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
119	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
				681.6701						$0.00		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 60LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 60

% Unnoc. lights: 19%
Gas Increase Factor 2.10E-03 MBtu/kWh
Cooling Factor (Energy) 1.22

NOTE: ALL ROOM LIGHT NUMBERS ON THIS SHEET ARE DOUBLED TO ACCOUNT FOR IDENTICAL WEST WING.

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours 'On' Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
5	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
5	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
6	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
6	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
7	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
7	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
8	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
8	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
9	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
9	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
10	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
10	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
11	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
11	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
12	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
12	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
13	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
13	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
17	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
17	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
18	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
18	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
19	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
19	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
20	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
20	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
14	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
14	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
15	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
15	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
16	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
16	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
23	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
23	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
24	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
24	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
25	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
25	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
26	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
26	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
27	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
27	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
28	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
28	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
29	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
29	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
30	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
				0						$0.00		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 60LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 60

Sheet 3 of 3

% Unnoc. lights: 19%
Gas Increase Factor 2.10E-03 MBtu/kWh
Cooling Factor (Energy) 1.22

NOTE: ALL ROOM LIGHT NUMBERS ON THIS SHEET ARE DOUBLED TO ACCOUNT FOR IDENTICAL WEST WING.

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
30	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
31	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
31	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
32	0.36	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
32	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
33	0.36	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
33	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
34	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
34	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
35	0.18	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
35	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
36	0.89	6411	0.17	1084	2.277	1323	0	$0.00	NO	$0.00	YES	$372.00
36	0.72	6411	0.14	187	0.393	228	3	$1,188.51	NO	$0.00	YES	$372.00
37	0.36	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
37	0.53	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
38	0.36	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
38	0.09	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
Corr-1	1.42	6411	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
Total	**15.769**		**0.4332**	**1271.3**	**4.10124**	**2382.624**	**7**	**$2,773.19**		**$0.00**		**$1,488.00**

Total $ Expense = $4,261.19

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 21-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 101LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 12

BUILDING NUMBER: 101

Sheet 1 of 1

Schedule #1	M-F	700 to	1850	S-S	0 to	0
Schedule #2	M-F	0 to	0	S-S	0 to	0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
1	3	4x2-4 lamp fluorescent	off	yes	yes	1	no
2	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
3	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
4	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
5	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
6	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
7	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
8	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
9	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
10	4	4x2-4 lamp fluorescent	on	yes	no	1	no
11	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
12	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
13	4	4x2-4 lamp fluorescent	on	yes	no	1	no
14	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
15	6	4x2-4 lamp fluorescent	on	yes	yes	1	no
16	6	4x2-4 lamp fluorescent	on	yes	no	1	no
17	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
18	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
19	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
20	4	4x2-4 lamp fluorescent	on	yes	no	1	no
21	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
22	9	4x2-4 lamp fluorescent	on	yes	no	2	no
23	3	4x2-4 lamp fluorescent	off	yes	no	1	no
24	1	4x2-4 lamp fluorescent	off	yes	no	1	no
25	4	4x2-4 lamp fluorescent	on	yes	no	1	no
26	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
27	7	8'-2 lamp fluorescent	on	yes	no	2	no
28	3	8'-2 lamp fluorescent	on	yes	no	1	no
29	4	4x2-2 lamp fluorescent	on	yes	no	1	no
30	4	4x2-2 lamp fluorescent	on	yes	no	1	no
31	7	4x2-2 lamp fluorescent	on	yes	no	1	yes
32	1	4x2-2 lamp fluorescent	on	yes	no	1	no
34	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
35	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
36	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
37	3	4x2-4 lamp fluorescent	on	yes	no	1	no
38	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
39	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
40	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
41	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
42	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
43	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
44	2	4x2-4 lamp fluorescent	on	yes	yes	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 21–Apr–92

ECO:15–LIGHTING CONTROL

FILE: 101LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21–91–C–0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 101

Sheet 1 of 1

% Unnoc. lights: 19%
Gas Increase Factor 2.20E–04 MBtu/kWh
Cooling Factor (Energy) 1.19

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
1	0.47	3132	0.09	277	0.061	329	0	$0.00	YES	$65.11	NO	$0.00
2	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
3	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
4	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
5	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
6	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
7	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
8	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
9	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
10	0.62	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
11	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
12	0.62	3132	0.12	369	0.081	439	0	$0.00	NO	$0.00	YES	$372.00
13	0.62	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
14	0.47	3132	0.09	277	0.061	329	0	$0.00	YES	$65.11	NO	$0.00
15	0.93	3132	0.18	553	0.122	659	0	$0.00	NO	$0.00	YES	$372.00
16	0.93	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
17	0.16	3132	0.03	92	0.020	110	0	$0.00	YES	$65.11	NO	$0.00
18	0.47	3132	0.09	277	0.061	329	0	$0.00	YES	$65.11	NO	$0.00
19	0.62	3132	0.12	369	0.081	439	0	$0.00	NO	$0.00	YES	$372.00
20	0.62	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
21	0.47	3132	0.09	277	0.061	329	0	$0.00	YES	$65.11	NO	$0.00
22	1.40	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
23	0.47	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
24	0.16	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
25	0.62	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
26	0.62	3132	0.12	369	0.081	439	0	$0.00	NO	$0.00	YES	$372.00
27	1.47	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
28	0.63	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
29	0.36	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
30	0.36	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
31	0.62	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
32	0.09	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
34	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
35	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
36	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
37	0.47	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
38	0.16	3132	0.03	92	0.020	110	0	$0.00	YES	$65.11	NO	$0.00
39	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
40	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
41	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
42	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
43	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
44	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
Total	19.954		2.0026	6272.143	1.37987	7463.85	0	$0.00		$1,562.64		$1,488.00

Total $ Expense = $3,050.64

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 170LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 20

BUILDING NUMBER: 170

Schedule #1 M-F 700 to 2200 S-S 700 to 2200
Schedule #2 M-F 0 to 2400 S-S 0 to 2400

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
1	1	4x2-4 lamp fluorescent	off	yes	no	1	no
2	1	150 Watt Incandescent	off	yes	no	1	no
28	4	4x2-2 lamp fluorescent	off	yes	no	1	no
5	1	4x2-4 lamp fluorescent	on	yes	no	1	no
6	4	4x2-4 lamp fluorescent	on	yes	no	1	no
9	6	4x2-4 lamp fluorescent	on	yes	no	1	no
9	15	4x2-2 lamp fluorescent	on	yes	no	1	no
29	6	4x2-2 lamp fluorescent	on	yes	no	1	no
17	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
21	7	4x2-2 lamp fluorescent	on	yes	no	1	no
27	1	4x2-4 lamp fluorescent	on	yes	no	1	no
25	1	4x2-2 lamp fluorescent	on	yes	no	1	no
24	4	4x2-2 lamp fluorescent	on	yes	no	1	no
23	2	4x2-2 lamp fluorescent	on	no	no	0	no
22	4	4x2-2 lamp fluorescent	on	yes	no	1	no
18	4	4x2-4 lamp fluorescent	off	yes	no	1	no
15	7	4x2-2 lamp fluorescent	on	no	no	0	no
14	5	4x2-2 lamp fluorescent	on	no	no	0	no
3	6	4x2-2 lamp fluorescent	on	yes	no	1	no
30	7	4x2-4 lamp fluorescent	on	yes	no	1	no
31	3	4x2-4 lamp fluorescent	on	yes	no	1	no
34	2	4x2-4 lamp fluorescent	on	yes	no	1	no
37	2	4x2-4 lamp fluorescent	on	yes	no	2	no
38	1	4x2-4 lamp fluorescent	on	yes	no	1	no
41	1	4x2-4 lamp fluorescent	on	yes	no	1	no
40	1	4x2-4 lamp fluorescent	on	no	yes	0	no
55	6	4x2-4 lamp fluorescent	on	yes	no	1	no
54	2	4x2-4 lamp fluorescent	on	yes	no	1	no
58	4	4x2-2 lamp fluorescent	on	yes	no	1	no
53	7	4x2-4 lamp fluorescent	on	yes	no	1	no
59	3	4x2-2 lamp fluorescent	on	yes	no	1	no
61	2	4x2-2 lamp fluorescent	on	no	no	0	no
71	3	4x2-4 lamp fluorescent	on	yes	no	1	no
70	1	4x2-4 lamp fluorescent	on	yes	no	1	no
69	3	4x2-4 lamp fluorescent	on	yes	no	1	no
68	1	4x2-4 lamp fluorescent	on	yes	no	1	no
60	3	4x2-4 lamp fluorescent	on	yes	no	1	no
65	2	4x2-4 lamp fluorescent	on	yes	no	1	no
66	1	4x2-4 lamp fluorescent	on	no	no	0	no
67	1	4x2-4 lamp fluorescent	on	no	no	0	no
68	1	4x2-4 lamp fluorescent	on	no	no	0	no
64	1	4x2-4 lamp fluorescent	on	yes	no	1	no
100	1	4x2-2 lamp fluorescent	on	yes	no	1	no
81	2	4x2-4 lamp fluorescent	on	yes	no	1	no
80	1	4x2-2 lamp fluorescent	on	yes	yes	1	no
72	1	4x2-4 lamp fluorescent	on	yes	no	1	no
73	1	4x2-4 lamp fluorescent	on	yes	yes	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION:

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 170LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 170

Schedule #1	M-F	700 to	2200	S-S	700 to	2200
Schedule #2	M-F	0 to	2400	S-S	0 to	2400

Room No.	# of Lights	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
74	1	4x2-4 lamp fluorescent	on	yes	no	1	no
74	2	4x2-4 lamp fluorescent	on	yes	no	1	no
79	1	4x2-4 lamp fluorescent	on	yes	no	1	no
42	1	4x2-4 lamp fluorescent	on	yes	no	1	no
52	2	4x2-4 lamp fluorescent	on	yes	no	1	no
43	1	4x2-4 lamp fluorescent	off	yes	no	1	no
44	1	4x2-4 lamp fluorescent	on	yes	no	1	no
45	1	4x2-4 lamp fluorescent	on	yes	no	1	no
46	1	4x2-4 lamp fluorescent	on	yes	no	1	no
47	1	4x2-4 lamp fluorescent	on	yes	no	1	no
102	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
103	1	4x2-2 lamp fluorescent	off	yes	yes	1	no
104	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
106	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
108	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
109	1	4x2-2 lamp fluorescent	on	yes	yes	1	yes
110	3	4x2-2 lamp fluorescent	on	yes	yes	2	yes
111	1	4x2-2 lamp fluorescent	off	yes	no	1	no
112	1	4x2-4 lamp fluorescent	on	yes	yes	2	no
116	1	4x2-2 lamp fluorescent	on	yes	yes	1	no
118	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
119	1	150 Watt Incandescent	on	yes	yes	1	yes
120	6	4x2-4 lamp fluorescent	on	yes	yes	1	no
122	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
119A	2	4x2-2 lamp fluorescent	on	yes	yes	1	no
HALL-1	7	4x2-2 lamp fluorescent	on	yes	no	1	no
HALL-2	1	4x2-2 lamp fluorescent	on	yes	no	1	no
HALL-3	2	4x2-2 lamp fluorescent	on	yes	no	1	no
HALL-4	1	4x2-2 lamp fluorescent	on	yes	no	1	no
HALL-5	2	4x2-2 lamp fluorescent	on	yes	no	1	no
HALL-6	3	4x2-2 lamp fluorescent	on	yes	no	1	no
121-137	18	4x2-4 lamp fluorescent	on	yes	yes	1	no
140-144	5	4x2-4 lamp fluorescent	on	yes	no	1	yes
154	1	4x2-2 lamp fluorescent	off	yes	yes	1	no
145	2	4x2-2 lamp fluorescent	off	yes	yes	1	no
146	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
147	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
148	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
150	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
149	1	4x2-4 lamp fluorescent	off	yes	no	1	no
153	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes

E M C ENGINEERS, INC.

OJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECC15-LIGHTING CONTROL

FILE: 170LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 170

% Unnoc. lights: 19%
Gas Increase Factor 1.68E-04 MBtu/kWh
Cooling Factor (Ene 1.145

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
1	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
2	0.15	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
28	0.36	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
5	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
6	0.62	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
9	0.93	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
9	1.34	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
29	0.53	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
17	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
21	0.62	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
27	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
25	0.09	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
24	0.36	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
23	0.18	5475	0.00	46	0.008	53	1	$396.17	NO	$0.00	NO	$0.00
22	0.36	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
18	0.62	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
15	0.62	5475	0.00	162	0.027	185	2	$792.34	NO	$0.00	NO	$0.00
14	0.45	5475	0.00	116	0.019	132	1	$396.17	NO	$0.00	NO	$0.00
3	0.53	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
30	1.08	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
31	0.47	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
34	0.31	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
37	0.31	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
38	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
41	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
40	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
55	0.93	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
54	0.31	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
58	0.36	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
53	1.08	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
59	0.27	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
61	0.18	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
71	0.47	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
70	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
69	0.47	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
68	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
60	0.47	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
65	0.31	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
66	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
67	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
68	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
64	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
100	0.09	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
81	0.31	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
80	0.09	5475	0.02	93	0.016	106	0	$0.00	YES	$65.11	NO	$0.00
72	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
73	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
				900.2585						$260.44		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECC15-LIGHTING CONTROL

FILE: 170LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 170

Sheet 2 of 2

% Unnoc. lights: 19%
Gas Increase Factor 1.30E-03 MBtu/kWh
Cooling Factor (Ene 1.16

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
74	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
74	0.31	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
79	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
42	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
52	0.31	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
43	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
44	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
45	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
46	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
47	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
102	0.31	5475	0.06	322	0.054	369	0	$0.00	YES	$65.11	NO	$0.00
103	0.09	5475	0.02	93	0.016	106	0	$0.00	YES	$65.11	NO	$0.00
104	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
106	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
108	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
109	0.09	5475	0.02	93	0.016	106	0	$0.00	YES	$65.11	NO	$0.00
110	0.27	5475	0.05	278	0.047	318	0	$0.00	YES	$65.11	NO	$0.00
111	0.09	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
112	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
116	0.09	5475	0.02	93	0.016	106	0	$0.00	YES	$65.11	NO	$0.00
118	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
119	0.15	5475	0.03	156	0.026	179	0	$0.00	YES	$65.11	NO	$0.00
120	0.93	5475	0.18	967	0.163	1108	0	$0.00	NO	$0.00	YES	$372.00
122	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
119A	0.18	5475	0.03	185	0.031	212	0	$0.00	YES	$65.11	NO	$0.00
HALL-	0.62	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
HALL-	0.09	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
HALL-	0.18	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
HALL-	0.09	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
HALL-	0.18	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
HALL-	0.27	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
121-1	2.79	5475	0.53	2902	0.488	3323	0	$0.00	NO	$0.00	YES	$372.00
140-1	0.78	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
154	0.09	5475	0.02	93	0.016	106	0	$0.00	YES	$65.11	NO	$0.00
145	0.18	5475	0.03	185	0.031	212	0	$0.00	YES	$65.11	NO	$0.00
146	0.18	5475	0.03	185	0.031	212	0	$0.00	YES	$65.11	NO	$0.00
147	0.18	5475	0.03	185	0.031	212	0	$0.00	YES	$65.11	NO	$0.00
148	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
150	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
149	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
153	0.31	5475	0.06	322	0.054	369	0	$0.00	YES	$65.11	NO	$0.00
Total	28.931		1.44761	8249.625	1.38594	9445.82	4	$1,584.68		$1,562.64		$744.00

Total $ Expense = $3,891.32

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 171LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 22

BUILDING NUMBER: 171

Schedule #1 M-F 700 to 1500 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
1	8	4x2-4 lamp fluorescent	on	yes	yes	1	no
1	13	2x2-2 U-Bulb fluorescent	on	yes	yes	1	no
2	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
3	15	8'-2 lamp fluorescent	on	yes	yes	2	no
4	2	8'-2 lamp fluorescent	on	yes	yes	1	no
5	2	8'-2 lamp fluorescent	on	yes	yes	1	no
103	10	4x2-4 lamp fluorescent	on	yes	yes	2	no
108	5	4x2-4 lamp fluorescent	off	yes	yes	2	no
109	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
101	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
107	5	4x2-4 lamp fluorescent	on	yes	yes	1	no
125	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
128	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
127	4	4x2-2 lamp fluorescent	on	yes	yes	1	no
126	4	4x2-2 lamp fluorescent	on	yes	yes	1	no
111	8	4x2-2 lamp fluorescent	on	yes	yes	1	no
106	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
102	2	4x2-4 lamp fluorescent	on	yes	yes	2	no
120	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
201	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
203	8	4x2-4 lamp fluorescent	on	yes	yes	3	no
202	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
205	2	4x2-2 lamp fluorescent	on	yes	yes	1	no
206	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
207	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
208	2	4x2-2 lamp fluorescent	on	yes	yes	1	no
209	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
212	3	4x2-2 lamp fluorescent	on	yes	yes	1	no
210	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
213	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
214	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
215	1	4x2-2 lamp fluorescent	on	yes	yes	1	no
217	1	4x2-2 lamp fluorescent	on	yes	yes	1	no
218	4	4x2-2 lamp fluorescent	on	yes	yes	1	no
219	4	4x2-2 lamp fluorescent	on	yes	yes	1	no
220	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
243	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
242	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
244	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
238	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
240	6	4x2-2 lamp fluorescent	on	yes	yes	2	no
222	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
223	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
225	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
239	2	4x2-4 lamp fluorescent	on	yes	yes	2	no
228	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
229	2	4x2-4 lamp fluorescent	on	yes	yes	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION: FORT McPHERSON

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 171LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 171

Sheet 2 of 2

Schedule #1	M-F	700 to	1500	S-S	0 to	0
Schedule #2	M-F	0 to	0	S-S	0 to	0

Room No.	# of Lights	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
230	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
231	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
227	30	4x2-2 lamp fluorescent	on	yes	yes	4	no
238	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
232	4	4x2-2 lamp fluorescent	on	yes	yes	1	no
234	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
233	4	4x2-2 lamp fluorescent	on	yes	yes	1	no
235	2	4x2-2 lamp fluorescent	on	yes	yes	1	no
237	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
104	10	4x2-4 lamp fluorescent	on	yes	yes	2	no
105	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
144	1	4x2-2 lamp fluorescent	on	yes	yes	1	no
143	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
112	4	4x2-2 lamp fluorescent	on	yes	yes	1	no
113	4	4x2-2 lamp fluorescent	on	yes	yes	1	no
114	4	4x2-2 lamp fluorescent	on	yes	yes	1	no
115	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
116	2	4x2-2 lamp fluorescent	on	yes	yes	1	no
123	1	4x2-2 lamp fluorescent	on	yes	yes	1	no
124	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
122	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
121	12	4x2-2 lamp fluorescent	on	yes	yes	1	no
135	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
117	10	4x2-2 lamp fluorescent	on	yes	yes	4	no
118	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
136	1	4x2-2 lamp fluorescent	on	yes	yes	1	no
119	1	4x2-4 lamp fluorescent	on	yes	yes	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 171LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 171

% Unnoc. lights: 19%
Gas Increase Factor 1.30E-03 MBtu/kWh
Cooling Factor (Energy) 1.16

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
1	1.24	2088	0.24	492	0.640	571	0	$0.00	NO	$0.00	YES	$372.00
1	1.196	2088	0.23	474	0.617	550	0	$0.00	NO	$0.00	YES	$372.00
2	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
3	3.15	2088	0.60	1250	1.625	1450	0	$0.00	NO	$0.00	YES	$372.00
4	0.42	2088	0.08	167	0.217	193	0	$0.00	YES	$65.11	NO	$0.00
5	0.42	2088	0.08	167	0.217	193	0	$0.00	YES	$65.11	NO	$0.00
103	1.55	2088	0.29	615	0.799	713	0	$0.00	NO	$0.00	YES	$372.00
108	0.775	2088	0.15	307	0.400	357	0	$0.00	NO	$0.00	YES	$372.00
109	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
101	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
107	0.775	2088	0.15	307	0.400	357	0	$0.00	NO	$0.00	YES	$372.00
125	0.465	2088	0.09	184	0.240	214	0	$0.00	YES	$65.11	NO	$0.00
128	0.62	2088	0.12	246	0.320	285	0	$0.00	NO	$0.00	YES	$372.00
127	0.356	2088	0.07	141	0.184	164	0	$0.00	NO	$0.00	YES	$372.00
126	0.356	2088	0.07	141	0.184	164	0	$0.00	NO	$0.00	YES	$372.00
111	0.712	2088	0.14	282	0.367	328	0	$0.00	NO	$0.00	YES	$372.00
106	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
102	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
120	0.465	2088	0.09	184	0.240	214	0	$0.00	YES	$65.11	NO	$0.00
201	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
203	1.24	2088	0.24	492	0.640	571	0	$0.00	NO	$0.00	YES	$372.00
202	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
205	0.178	2088	0.03	71	0.092	82	0	$0.00	YES	$65.11	NO	$0.00
206	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
207	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
208	0.178	2088	0.03	71	0.092	82	0	$0.00	YES	$65.11	NO	$0.00
209	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
212	0.267	2088	0.05	106	0.138	123	0	$0.00	YES	$65.11	NO	$0.00
210	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
213	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
214	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
215	0.089	2088	0.02	35	0.046	41	0	$0.00	YES	$65.11	NO	$0.00
217	0.089	2088	0.02	35	0.046	41	0	$0.00	YES	$65.11	NO	$0.00
218	0.356	2088	0.07	141	0.184	164	0	$0.00	NO	$0.00	YES	$372.00
219	0.356	2088	0.07	141	0.184	164	0	$0.00	NO	$0.00	YES	$372.00
220	0.62	2088	0.12	246	0.320	285	0	$0.00	NO	$0.00	YES	$372.00
243	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
242	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
244	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
238	0.465	2088	0.09	184	0.240	214	0	$0.00	YES	$65.11	NO	$0.00
240	0.534	2088	0.10	212	0.275	246	0	$0.00	NO	$0.00	YES	$372.00
222	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
223	0.465	2088	0.09	184	0.240	214	0	$0.00	YES	$65.11	NO	$0.00
225	0.465	2088	0.09	184	0.240	214	0	$0.00	YES	$65.11	NO	$0.00
239	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
228	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
229	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
				9091.632						$2,083.52		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 171LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 171

% Unnoc. lights: 19%
Gas Increase Factor 1.30E-03 MBtu/kWh
Cooling Factor (Energy) 1.16

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
230	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
231	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
227	2.67	2088	0.51	1059	1.377	1229	0	$0.00	NO	$0.00	YES	$372.00
238	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
232	0.356	2088	0.07	141	0.184	164	0	$0.00	NO	$0.00	YES	$372.00
234	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
233	0.356	2088	0.07	141	0.184	164	0	$0.00	NO	$0.00	YES	$372.00
235	0.178	2088	0.03	71	0.092	82	0	$0.00	YES	$65.11	NO	$0.00
237	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
104	1.55	2088	0.29	615	0.799	713	0	$0.00	NO	$0.00	YES	$372.00
105	0.62	2088	0.12	246	0.320	285	0	$0.00	NO	$0.00	YES	$372.00
144	0.089	2088	0.02	35	0.046	41	0	$0.00	YES	$65.11	NO	$0.00
143	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
112	0.356	2088	0.07	141	0.184	164	0	$0.00	NO	$0.00	YES	$372.00
113	0.356	2088	0.07	141	0.184	164	0	$0.00	NO	$0.00	YES	$372.00
114	0.356	2088	0.07	141	0.184	164	0	$0.00	NO	$0.00	YES	$372.[illegible]
115	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.[illegible]
116	0.178	2088	0.03	71	0.092	82	0	$0.00	YES	$65.11	NO	$0.00
123	0.089	2088	0.02	35	0.046	41	0	$0.00	YES	$65.11	NO	$0.00
124	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
122	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
121	1.068	2088	0.20	424	0.551	491	0	$0.00	NO	$0.00	YES	$372.00
135	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
117	0.89	2088	0.17	353	0.459	410	0	$0.00	NO	$0.00	YES	$372.00
118	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
136	0.089	2088	0.02	35	0.046	41	0	$0.00	YES	$65.11	NO	$0.00
119	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
Total	**34.598**		**6.57362**	**13725.72**	**17.8434**	**15921.8335**	**0**	**$0.00**		**$3,190.39**		**$9,300.00**
				Total $ Expense =		**$12,490.39**						

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 181LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 30

BUILDING NUMBER: 181

Sheet 1 of 1

Schedule #1	M-F	700 to	1900	S-S	0 to	0
Schedule #2	M-F	0 to	0	S-S	0 to	0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
Pay Area	15	4x2-4 lamp fluorescent	on	yes	no	3	no
Lobby	20	4x2-4 lamp fluorescent	on	yes	no	4	no
Entry	2	4x2-2 lamp fluorescent	on	yes	no	1	no
Travel Area	25	4x2-4 lamp fluorescent	on	yes	no	4	no
Jump Res.	25	4x2-4 lamp fluorescent	on	yes	no	4	no
109	4	4x2-4 lamp fluorescent	on	yes	no	1	no
122	2	4x2-4 lamp fluorescent	off	yes	no	1	no
123	2	4x2-4 lamp fluorescent	off	no	no	0	no
120	2	4x2-4 lamp fluorescent	on	yes	no	1	no
119	4	4x2-4 lamp fluorescent	on	yes	no	1	no
118	20	4x2-4 lamp fluorescent	on	yes	no	2	no
113B	9	4x2-4 lamp fluorescent	on	yes	no	2	no
113A	6	4x2-4 lamp fluorescent	on	yes	no	1	no
114	9	4x2-4 lamp fluorescent	on	yes	no	2	no
116	8	4x2-4 lamp fluorescent	on	yes	no	2	no
117	12	4x2-4 lamp fluorescent	on	yes	no	2	no
115	9	4x2-4 lamp fluorescent	on	yes	no	2	no
307	2	4x2-4 lamp fluorescent	on	yes	no	1	no
305	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
304	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
303	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
302	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
301	6	4x2-4 lamp fluorescent	on	yes	no	1	no
105	2	4x2-4 lamp fluorescent	on	yes	no	1	no
101	6	4x2-4 lamp fluorescent	on	yes	no	1	no
107	20	4x2-4 lamp fluorescent	on	yes	no	4	no
108	20	4x2-4 lamp fluorescent	on	yes	no	4	no
110	24	4x2-4 lamp fluorescent	on	yes	no	4	no
117	80	4x2-4 lamp fluorescent	on	yes	no	10	no
212	7	4x2-4 lamp fluorescent	on	yes	no	1	no
211	2	4x2-4 lamp fluorescent	on	yes	no	1	no
201	6	4x2-4 lamp fluorescent	on	yes	no	1	no
202	6	4x2-4 lamp fluorescent	on	yes	no	1	no
209	1	4x2-4 lamp fluorescent	on	yes	no	1	no
103	8	4x2-4 lamp fluorescent	on	yes	no	1	no
104	2	4x2-4 lamp fluorescent	on	yes	no	1	no
102	3	4x2-2 lamp fluorescent	on	yes	no	1	no
121	3	4x2-4 lamp fluorescent	on	yes	no	1	no
106	12	4x2-4 lamp fluorescent	on	yes	no	1	no
107	5	4x2-4 lamp fluorescent	on	yes	no	1	no
111	14	4x2-4 lamp fluorescent	on	yes	no	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 181LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 181

Sheet 1 of 1

% Unnoc. lights: 19%
Gas Increase Factor 5.87E-05 MBtu/kWh
Cooling Factor (Energy) 1.02E+00

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
Pay Area	2.33	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
Lobby	3.10	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
Entry	0.18	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
Travel Ar	3.88	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
Jump Re	3.88	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
109	0.62	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
122	0.31	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
123	0.31	3132	0.00	81	0.005	83	1	$396.17	NO	$0.00	NO	$0.00
120	0.31	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
119	0.62	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
118	3.10	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
113B	1.40	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
113A	0.93	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
114	1.40	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
116	1.24	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
117	1.86	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
115	1.40	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
307	0.31	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
305	0.62	3132	0.12	369	0.022	378	0	$0.00	NO	$0.00	YES	$372.00
304	0.31	3132	0.06	184	0.011	189	0	$0.00	YES	$65.11	NO	$0.00
303	0.31	3132	0.06	184	0.011	189	0	$0.00	YES	$65.11	NO	$0.00
302	0.18	3132	0.03	106	0.006	108	0	$0.00	YES	$65.11	NO	$0.00
301	0.93	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
105	0.31	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
101	0.93	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
107	3.10	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
108	3.10	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
110	3.72	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
117	12.40	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
212	1.08	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
211	0.31	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
201	0.93	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
202	0.93	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
209	0.16	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
103	1.24	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
104	0.31	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
102	0.27	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
121	0.47	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
106	1.86	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
107	0.78	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
111	2.17	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
Total	63.553		0.26942	924.4234	0.05426	946.6096	1	$396.17		$195.33		$372.00

Total $ Expense = $963.50

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 184LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 24

BUILDING NUMBER: 184

Sheet 1 of 1

Schedule #1	M-F	600 to	1900	S-S	0 to	0
Schedule #2	M-F	0 to	0	S-S	0 to	0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
B-MENT	100	4x2-2 lamp fluorescent	on	no	no	0	no
1	2	4x2-4 lamp fluorescent	on	yes	no	1	no
2	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
3	4	4x2-4 lamp fluorescent	on	yes	no	2	yes
4	4	4x2-4 lamp fluorescent	on	yes	no	1	no
5	2	4x2-4 lamp fluorescent	on	yes	no	1	no
6	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
7	10	4x2-4 lamp fluorescent	on	yes	no	2	yes
8	4	4x2-4 lamp fluorescent	off	yes	no	1	no
9	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
10	24	4x2-4 lamp fluorescent	on	yes	no	4	no
11	12	4x2-4 lamp fluorescent	on	yes	no	3	no
12	3	4x2-4 lamp fluorescent	on	yes	no	2	no
12	1	200 Watt Incandescent	on	yes	no	1	no
13	3	200 Watt Incandescent	on	yes	no	3	no
14	3	4x2-4 lamp fluorescent	on	yes	no	1	no
15	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
16	2	4x2-4 lamp fluorescent	on	yes	no	1	no
17	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
18	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
19	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
20	3	4x2-4 lamp fluorescent	on	yes	no	1	no
21	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
22	3	4x2-4 lamp fluorescent	on	yes	no	2	no
22	1	200 Watt Incandescent	on	yes	no	1	no
23	3	200 Watt Incandescent	off	yes	no	3	no
24	36	4x2-4 lamp fluorescent	on	yes	no	4	no
25	15	4x2-4 lamp fluorescent	on	yes	no	3	no
26	14	4x2-4 lamp fluorescent	on	yes	no	2	no
27	3	4x2-4 lamp fluorescent	on	yes	no	3	yes
27	1	200 Watt Incandescent	on	yes	no	1	yes
A	40	4x2-4 lamp fluorescent	on	no	no	2	no
B	40	4x2-4 lamp fluorescent	on	no	no	2	no
C	26	4x2-4 lamp fluorescent	on	no	no	2	no
D	3	200 Watt Incandescent	off	no	no	2	no
E	42	4x2-4 lamp fluorescent	on	no	no	2	no
ATTIC	30	120 Watt Incandescent	on	no	no	2	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 184LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 184

Sheet 1 of 1

% Unnoc. lights: 19%
Gas Increase Factor 5.40E-04 MBtu/kWh
Cooling Factor (Energy) 1.17

Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches: No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
B-MENT	8.90	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
1	0.31	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
2	0.47	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
3	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
4	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
5	0.31	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
6	0.31	3393	0.06	200	0.108	234	0	$0.00	YES	$65.11	NO	$0.00
7	1.55	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
8	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
9	0.16	3393	0.03	100	0.054	117	0	$0.00	YES	$65.11	NO	$0.00
10	3.72	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
11	1.86	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
12	0.47	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
12	0.20	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
13	0.60	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
14	0.47	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
15	0.31	3393	0.06	200	0.108	234	0	$0.00	YES	$65.11	NO	$0.00
16	0.31	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
17	0.47	3393	0.09	300	0.162	351	0	$0.00	YES	$65.11	NO	$0.00
18	0.31	3393	0.06	200	0.108	234	0	$0.00	YES	$65.11	NO	$0.00
19	0.47	3393	0.09	300	0.162	351	0	$0.00	YES	$65.11	NO	$0.00
20	0.47	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
21	0.31	3393	0.06	200	0.108	234	0	$0.00	YES	$65.11	NO	$0.00
22	0.47	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
22	0.20	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
23	0.60	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
24	5.58	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
25	2.33	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
26	2.17	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
27	0.47	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
27	0.20	3393	0.00	52	0.028	61	1	$396.17	NO	$0.00	NO	$0.00
A	6.20	3393	0.00	1612	0.870	1886	7	$2,773.19	NO	$0.00	NO	$0.00
B	6.20	3393	0.00	1612	0.870	1886	7	$2,773.19	NO	$0.00	NO	$0.00
C	4.03	3393	0.00	1048	0.566	1226	5	$1,980.85	NO	$0.00	NO	$0.00
D	0.60	3393	0.00	156	0.084	183	1	$396.17	NO	$0.00	NO	$0.00
E	6.51	3393	0.00	1693	0.914	1980	7	$2,773.19	NO	$0.00	NO	$0.00
ATTIC	3.60	3393	0.00	936	0.505	1095	5	$1,980.85	NO	$0.00	NO	$0.00
Total	**62.95**	**125541**	**0.44175**	**8607.258**	**4.647919**	**10070.4916**	**33**	**$13,073.61**		**$455.77**		**$0.00**

Total $ Expense = $13,529.38

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 246LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 21

BUILDING NUMBER: 246

Sheet 1 of 1

Schedule #1 M-F 600 to 1900 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
154	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
153	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
152	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
151	3	4x2-4 lamp fluorescent	on	yes	no	1	no
155	4	4x2-4 lamp fluorescent	on	yes	no	1	no
102	4	4x2-4 lamp fluorescent	on	yes	no	1	no
103	6	4x2-4 lamp fluorescent	on	yes	no	1	no
106	4	4x2-4 lamp fluorescent	off	yes	yes	1	no
107	58	4x2-4 lamp fluorescent	on	yes	no	10	no
148	16	4x2-4 lamp fluorescent	on	yes	no	2	yes
147	22	4x2-4 lamp fluorescent	off	yes	yes	1	no
149	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
146	16	4x2-4 lamp fluorescent	on	yes	no	4	no
144	12	4x2-4 lamp fluorescent	on	yes	no	2	no
143	6	4x2-4 lamp fluorescent	on	yes	yes	1	yes
142	4	4x2-4 lamp fluorescent	on	yes	no	1	no
141	4	4x2-2 lamp fluorescent	on	yes	yes	1	no
136	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
139	2	8'-2 lamp fluorescent	off	yes	no	1	no
138	2	8'-2 lamp fluorescent	off	yes	no	1	no
109	31	4x2-4 lamp fluorescent	on	yes	no	4	no
110	5	4x2-4 lamp fluorescent	on	yes	yes	1	yes
111	16	4x2-4 lamp fluorescent	on	yes	no	4	no
115	3	4x2-4 lamp fluorescent	on	yes	no	1	no
113	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
116	8	4x2-4 lamp fluorescent	on	yes	no	2	no
124	34	4x2-4 lamp fluorescent	on	yes	no	5	no
119	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
120	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
122	1	4x2-4 lamp fluorescent	off	yes	yes	1	yes
123	2	4x2-4 lamp fluorescent	on	yes	yes	2	no
125	4	4x2-4 lamp fluorescent	on	yes	no	1	no
126	2	4x2-4 lamp fluorescent	on	yes	no	1	no
134	24	4x2-4 lamp fluorescent	on	yes	no	4	no
133	1	4x2-4 lamp fluorescent	on	yes	no	1	no
132	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
131	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
130	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
128	4	4x2-4 lamp fluorescent	on	yes	no	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 246LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 246

% Unnoc. lights: 19%
Gas Increase Factor 4.40E-04 MBtu/kWh
Cooling Factor (Energ 1.18

Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches: No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
154	0.62	3393	0.12	400	0.176	472	0	$0.00	NO	$0.00	YES	$372.00
153	0.31	3393	0.06	200	0.088	236	0	$0.00	YES	$65.11	NO	$0.00
152	0.31	3393	0.06	200	0.088	236	0	$0.00	YES	$65.11	NO	$0.00
151	0.47	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
155	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
102	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
103	0.93	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
106	0.62	3393	0.12	400	0.176	472	0	$0.00	NO	$0.00	YES	$372.00
107	8.99	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
148	2.48	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
147	3.41	3393	0.65	2198	0.967	2594	0	$0.00	NO	$0.00	YES	$372.00
149	0.16	3393	0.03	100	0.044	118	0	$0.00	YES	$65.11	NO	$0.00
146	2.48	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
144	1.86	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
143	0.93	3393	0.18	600	0.264	707	0	$0.00	NO	$0.00	YES	$372.00
142	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
141	0.36	3393	0.07	230	0.101	271	0	$0.00	NO	$0.00	YES	$372.00
136	0.31	3393	0.06	200	0.088	236	0	$0.00	YES	$65.11	NO	$0.00
139	0.42	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
138	0.42	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
109	4.80	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
110	0.78	3393	0.15	500	0.220	590	0	$0.00	NO	$0.00	YES	$372.00
111	2.48	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
115	0.47	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
113	0.62	3393	0.12	400	0.176	472	0	$0.00	NO	$0.00	YES	$372.00
116	1.24	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
124	5.27	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
119	0.62	3393	0.12	400	0.176	472	0	$0.00	NO	$0.00	YES	$372.00
120	0.62	3393	0.12	400	0.176	472	0	$0.00	NO	$0.00	YES	$372.00
122	0.16	3393	0.03	100	0.044	118	0	$0.00	YES	$65.11	NO	$0.00
123	0.31	3393	0.06	200	0.088	236	0	$0.00	YES	$65.11	NO	$0.00
125	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
126	0.31	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
134	3.72	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
133	0.16	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
132	0.47	3393	0.09	300	0.132	354	0	$0.00	YES	$65.11	NO	$0.00
131	0.47	3393	0.09	300	0.132	354	0	$0.00	YES	$65.11	NO	$0.00
130	0.47	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
128	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
Total	**51.106**		**2.09969**	**7124.248**	**3.13467**	**8406.613**	**0**	**$0.00**		**$520.88**		**$3,348.00**
Total $ Saved/Year	**$199.64**			**Total $ Expense =**		**$3,868.88**						

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 363LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 85

BUILDING NUMBER: 363

Schedule #1	M-F	600 to	1900	S-S	0 to	0
Schedule #2	M-F	0 to	0	S-S	0 to	0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
22	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
23	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
24	10	4x2-4 lamp fluorescent	off	yes	yes	2	no
25	4	4x2-4 lamp fluorescent	off	yes	yes	1	no
26	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
27	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
28	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
29	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
30	1	4x2-4 lamp fluorescent	off	yes	no	1	no
30	1	4x2-2 lamp fluorescent	off	yes	no	1	no
31	29	8'-2 lamp fluorescent	off	yes	no	1	no
31	4	4x2-2 lamp fluorescent	off	yes	no	1	no
32	2	4x2-4 lamp fluorescent	off	yes	no	1	no
33	3	8'-2 lamp fluorescent	on	yes	no	1	yes
34	13	8'-2 lamp fluorescent	off	yes	no	1	no
36	1	8'-2 lamp fluorescent	on	yes	no	1	yes
36	3	120 Watt Incandescent	off	yes	no	1	no
35	30	8'-2 lamp fluorescent	on	yes	no	1	yes
37	6	4x2-4 lamp fluorescent	on	yes	yes	1	yes
37	2	2x2-2 U-Bulb fluorescent	on	yes	yes	1	yes
38	4	8'-2 lamp fluorescent	on	yes	no	1	yes
39	2	2x2-2 U-Bulb fluorescent	on	yes	yes	1	yes
39	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
40	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
D	1	75 Watt Incandescent	off	yes	no	1	no
E	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
E	1	300 Watt Incandescent	off	yes	no	1	yes
F	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
F	4	8'-2 lamp fluorescent	on	yes	yes	1	yes
13	3	150 Watt Incandescent	on	yes	no	1	yes
14	5	8'-2 lamp fluorescent	on	yes	no	1	yes
14	10	150 Watt Incandescent	off	yes	no	1	no
15	3	150 Watt Incandescent	off	yes	no	1	no
16	3	150 Watt Incandescent	off	yes	no	1	no
16	16	8'-2 lamp fluorescent	off	yes	no	1	no
17	6	8'-2 lamp fluorescent	off	yes	no	1	no
18	3	8'-2 lamp fluorescent	off	yes	no	1	no
18	9	120 Watt Incandescent	off	yes	no	1	no
18	11	120 Watt Incandescent	on	yes	no	1	yes
19	4	4x2-4 lamp fluorescent	off	yes	yes	1	no
20	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
21	11	4x2-4 lamp fluorescent	on	yes	no	1	yes
1	10	8'-2 lamp fluorescent	on	yes	no	1	yes
1	6	150 Watt Incandescent	on	yes	no	1	yes
2	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
3	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
4	9	8'-2 lamp fluorescent	on	yes	no	1	yes

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION:

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 363LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 363

Schedule #1 M-F 600 to 1900 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Lights	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
5	2	8'-2 lamp fluorescent	on	yes	no	1	yes
6	6	4x2-4 lamp fluorescent	on	yes	yes	1	yes
7	7	8'-2 lamp fluorescent	on	yes	no	1	yes
8	5	8'-2 lamp fluorescent	on	yes	no	1	no
9	17	8'-2 lamp fluorescent	on	yes	no	1	yes
9	2	150 Watt Incandescent	on	yes	no	1	yes
10	8	8'-2 lamp fluorescent	on	yes	no	1	no
11	19	8'-2 lamp fluorescent	on	yes	no	1	no
12	5	8'-2 lamp fluorescent	on	yes	no	1	yes
12	6	200 Watt Incandescent	on	yes	no	1	yes
A	4	120 Watt Incandescent	off	no	no	0	no
C	1	8'-2 lamp fluorescent	off	yes	no	1	no
B	1	120 Watt Incandescent	off	yes	no	1	no
21D2	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
21E1	4	4x2-4 lamp fluorescent	on	yes	no	1	yes
21E3	4	4x2-4 lamp fluorescent	on	yes	no	1	no
21F1	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
21F3	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
21F4	2	4x2-4 lamp fluorescent	on	no	yes	0	yes
21G3	6	4x2-4 lamp fluorescent	on	yes	yes	2	no
21G1A	1	4x2-4 lamp fluorescent	on	yes	no	1	yes
21G1B	1	4x2-4 lamp fluorescent	on	yes	no	0	yes
21C1	2	4x2-4 lamp fluorescent	off	yes	no	2	no
23A1	3	4x2-4 lamp fluorescent	off	yes	yes	1	no
23D1	39	4x2-4 lamp fluorescent	off	yes	no	5	no
24G2	6	4x2-4 lamp fluorescent	off	yes	no	2	no
24G1	2	4x2-4 lamp fluorescent	on	yes	no	1	no
23G3	2	4x2-4 lamp fluorescent	on	yes	no	1	no
23G1	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
Weight Rm	8	4x2-4 lamp fluorescent	on	yes	yes	2	yes
Locker	3	4x2-2 lamp fluorescent	on	yes	yes	1	yes
Locker	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
Locker	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
4A1	5	4x2-4 lamp fluorescent	on	no	no	0	yes
4D1	2	4x2-4 lamp fluorescent	on	no	yes	0	yes
1E1	42	4x2-2 lamp fluorescent	on	no	no	0	no
3E1	7	4x2-2 lamp fluorescent	on	yes	no	1	yes
1D1	29	4x2-2 lamp fluorescent	on	yes	no	1	no
1C2	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
3C1	16	4x2-4 lamp fluorescent	on	yes	no	1	no
3B1	4	4x2-2 lamp fluorescent	on	yes	no	1	yes
1A3	6	4x2-4 lamp fluorescent	on	yes	no	1	no
3A1	6	4x2-4 lamp fluorescent	on	yes	no	1	no
1A4	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
1A5	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
1A1	6	4x2-4 lamp fluorescent	on	yes	yes	1	no
2A1	1	4x2-4 lamp fluorescent	on	yes	no	1	yes

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION:

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 363LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 363

Sheet 3 of 4

Schedule #1	M-F	600 to	1900	S-S	0 to	0
Schedule #2	M-F	0 to	0	S-S	0 to	0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
21E2	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
21E2	3	75 Watt Incandescent	on	yes	no	2	no
21D3	1	4x2-2 lamp fluorescent	on	yes	no	1	no
21D4	4	4x2-4 lamp fluorescent	on	yes	no	1	no
21D1	4	4x2-4 lamp fluorescent	on	yes	no	1	no
11F2	2	4x2-4 lamp fluorescent	on	yes	no	1	no
91B	2	4x2-4 lamp fluorescent	on	yes	no	1	no
8F2	2	4x2-4 lamp fluorescent	on	yes	no	2	no
9F1	2	4x2-4 lamp fluorescent	on	yes	no	2	no
73	9	4x2-4 lamp fluorescent	on	yes	no	1	no
7F2	6	4x2-4 lamp fluorescent	on	yes	no	1	yes
7D3	5	4x2-4 lamp fluorescent	on	yes	no	1	no
7E1	2	4x2-4 lamp fluorescent	on	yes	no	1	no
7D2	1	4x2-2 lamp fluorescent	off	yes	no	1	no
6D1	3	4x2-4 lamp fluorescent	on	yes	no	1	no
6F1	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
6E1	68	4x2-4 lamp fluorescent	on	yes	no	1	no
6A1	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
6A2	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
7A1	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
7A2	10	4x2-4 lamp fluorescent	on	yes	no	1	no
4C1A	6	4x2-4 lamp fluorescent	on	no	yes	0	yes
4A1A	1	4x2-4 lamp fluorescent	on	no	yes	0	yes
12C1	4	4x2-4 lamp fluorescent	on	no	no	0	no
12B1	2	4x2-4 lamp fluorescent	on	yes	no	1	no
11D1	5	4x2-4 lamp fluorescent	on	yes	no	1	no
11A1	2	4x2-4 lamp fluorescent	on	no	no	0	no
10B1	40	4x2-4 lamp fluorescent	on	no	no	0	no
10A1	4	4x2-4 lamp fluorescent	off	yes	yes	1	no
9B1	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
9A5	4	4x2-4 lamp fluorescent	off	yes	yes	1	no
9A6	3	4x2-4 lamp fluorescent	off	yes	yes	1	no
9C1	1	75 Watt Incandescent	off	yes	no	1	no
8D1	8	4x2-4 lamp fluorescent	on	yes	no	1	no
10E1	26	4x2-4 lamp fluorescent	on	yes	no	1	no
9E2	1	75 Watt Incandescent	off	yes	no	1	no
9F2	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
9O3	4	4x2-2 lamp fluorescent	on	yes	yes	1	yes
10F1	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
10F2	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
11F1	1	4x2-2 lamp fluorescent	on	yes	yes	1	yes
14E2	4	4x2-4 lamp fluorescent	on	yes	no	1	no
15E1	15	4x2-4 lamp fluorescent	on	yes	no	1	no
15F2	8	4x2-4 lamp fluorescent	on	yes	no	1	no
14F2	2	4x2-4 lamp fluorescent	on	yes	no	1	no
15F1	2	4x2-4 lamp fluorescent	on	yes	no	1	no
14F1	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION:

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 363LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 363

Schedule #1 M-F 600 to 1900 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Lights	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
13F1	13	4x2-4 lamp fluorescent	on	yes	no	2	no
13F2	1	75 Watt Incandescent	off	yes	no	1	no
12F3	4	4x2-4 lamp fluorescent	off	yes	yes	1	no
12F4	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
12F1	1	4x2-4 lamp fluorescent	off	yes	no	1	no
12D1	12	4x2-4 lamp fluorescent	on	yes	no	1	no
12C2A	11	4x2-4 lamp fluorescent	on	yes	no	1	no
13C1	4	4x2-4 lamp fluorescent	off	yes	yes	1	no
13B1	16	4x2-4 lamp fluorescent	on	yes	no	1	no
13C2	1	4x2-4 lamp fluorescent	off	yes	no	1	no
13B1A	2	4x2-4 lamp fluorescent	off	yes	yes	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 363LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 363

% Unnoc. lights: 19%
Gas Increase Factor 1.90E-03 MBtu/kWh
Cooling Factor (Energy) 0

Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches: No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
22	0.31	3393	0.06	200	0.380	0	0	$0.00	YES	$65.11	NO	$0.00
23	0.31	3393	0.06	200	0.380	0	0	$0.00	YES	$65.11	NO	$0.00
24	1.55	3393	0.29	999	1.899	0	0	$0.00	NO	$0.00	YES	$372.00
25	0.62	3393	0.12	400	0.759	0	0	$0.00	NO	$0.00	YES	$372.00
26	0.31	3393	0.06	200	0.380	0	0	$0.00	YES	$65.11	NO	$0.00
27	0.31	3393	0.06	200	0.380	0	0	$0.00	YES	$65.11	NO	$0.00
28	0.31	3393	0.06	200	0.380	0	0	$0.00	YES	$65.11	NO	$0.00
29	0.16	3393	0.03	100	0.190	0	0	$0.00	YES	$65.11	NO	$0.00
30	0.16	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
30	0.09	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
31	6.09	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
31	0.36	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
32	0.31	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
33	0.63	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
34	2.73	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
36	0.21	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
36	0.36	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
35	6.30	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
37	0.93	3393	0.18	600	1.139	0	0	$0.00	NO	$0.00	YES	$372.00
37	0.18	3393	0.03	119	0.225	0	0	$0.00	YES	$65.11	NO	$0.00
38	0.84	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
39	0.18	3393	0.03	119	0.225	0	0	$0.00	YES	$65.11	NO	$0.00
39	0.31	3393	0.06	200	0.380	0	0	$0.00	YES	$65.11	NO	$0.00
40	0.47	3393	0.09	300	0.570	0	0	$0.00	YES	$65.11	NO	$0.00
D	0.08	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
E	0.47	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
E	0.30	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
F	0.18	3393	0.03	115	0.218	0	0	$0.00	YES	$65.11	NO	$0.00
F	0.84	3393	0.16	542	1.029	0	0	$0.00	NO	$0.00	YES	$372.00
13	0.45	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
14	1.05	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
14	1.50	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
15	0.45	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
16	0.45	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
16	3.36	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
17	1.26	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
18	0.63	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
18	1.08	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
18	1.32	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
19	0.62	3393	0.12	400	0.759	0	0	$0.00	NO	$0.00	YES	$372.00
20	0.62	3393	0.12	400	0.759	0	0	$0.00	NO	$0.00	YES	$372.00
21	1.71	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
1	2.10	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
1	0.90	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
2	0.31	3393	0.06	200	0.380	0	0	$0.00	YES	$65.11	NO	$0.00
3	0.31	3393	0.06	200	0.380	0	0	$0.00	YES	$65.11	NO	$0.00
4	1.89	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
				5689.857						$846.43		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 363LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 363

Sheet 2 of 4

% Unnoc. lights: 19%
Gas Increase Factor 1.90E-03 MBtu/kWh
Cooling Factor (Energy) 0

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
5	0.42	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
6	0.93	3393	0.18	600	1.139	0	0	$0.00	NO	$0.00	YES	$372.00
7	1.47	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
8	1.05	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
9	3.57	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
9	0.30	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
10	1.68	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
11	3.99	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
12	1.05	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
12	1.20	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
A	0.48	3393	0.00	125	0.237	0	1	$396.17	NO	$0.00	NO	$0.00
C	0.21	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
B	0.12	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
21D2	0.31	3393	0.06	200	0.380	0	0	$0.00	YES	$65.11	NO	$0.00
21E1	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
21E3	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
21F1	0.47	3393	0.09	300	0.570	0	0	$0.00	YES	$65.11	NO	$0.00
21F3	0.31	3393	0.06	200	0.380	0	0	$0.00	YES	$65.11	NO	$0.00
21F4	0.31	3393	0.06	81	0.153	0	1	$396.17	YES	$65.11	NO	$0.00
21G3	0.93	3393	0.18	600	1.139	0	0	$0.00	NO	$0.00	YES	$372.00
21G1A	0.16	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
21G1B	0.16	3393	0.00	40	0.077	0	1	$396.17	NO	$0.00	NO	$0.00
21C1	0.31	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
23A1	0.47	3393	0.09	300	0.570	0	0	$0.00	YES	$65.11	NO	$0.00
23D1	6.05	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
24G2	0.93	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
24G1	0.31	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
23G3	0.31	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
23G1	0.62	3393	0.12	400	0.759	0	0	$0.00	NO	$0.00	YES	$372.00
Weight R	1.24	3393	0.24	799	1.519	0	0	$0.00	NO	$0.00	YES	$372.00
Locker	0.27	3393	0.05	172	0.327	0	0	$0.00	YES	$65.11	NO	$0.00
Locker	0.47	3393	0.09	300	0.570	0	0	$0.00	YES	$65.11	NO	$0.00
Locker	0.18	3393	0.03	115	0.218	0	0	$0.00	YES	$65.11	NO	$0.00
4A1	0.78	3393	0.00	202	0.383	0	1	$396.17	NO	$0.00	NO	$0.00
4D1	0.31	3393	0.06	81	0.153	0	1	$396.17	YES	$65.11	NO	$0.00
1E1	3.74	3393	0.00	972	1.847	0	7	$2,773.19	NO	$0.00	NO	$0.00
3E1	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
1D1	2.58	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
1C2	0.31	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
3C1	2.48	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
3B1	0.36	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
1A3	0.93	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
3A1	0.93	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
1A4	0.31	3393	0.06	200	0.380	0	0	$0.00	YES	$65.11	NO	$0.00
1A5	0.31	3393	0.06	200	0.380	0	0	$0.00	YES	$65.11	NO	$0.00
1A1	0.93	3393	0.18	600	1.139	0	0	$0.00	NO	$0.00	YES	$372.00
2A1	0.16	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
				6482.979						$716.21		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 363LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 363

% Unnoc. lights: 19%
Gas Increase Factor 1.90E-03 MBtu/kWh
Cooling Factor (Energy) 0

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
21E2	0.31	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
21E2	0.23	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
21D3	0.09	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
21D4	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
21D1	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
11F2	0.31	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
91B	0.31	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
8F2	0.31	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
9F1	0.31	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
73	1.40	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
7F2	0.93	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
7D3	0.78	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
7E1	0.31	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
7D2	0.09	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
6D1	0.47	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
[illegible]F1	0.31	3393	0.06	200	0.380	0	0	$0.00	YES	$65.11	NO	$0.00
6E1	10.54	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
6A1	0.62	3393	0.12	400	0.759	0	0	$0.00	NO	$0.00	YES	$372.00
6A2	0.62	3393	0.12	400	0.759	0	0	$0.00	NO	$0.00	YES	$372.00
7A1	0.62	3393	0.12	400	0.759	0	0	$0.00	NO	$0.00	YES	$372.00
7A2	1.55	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
4C1A	0.93	3393	0.18	242	0.459	0	1	$0.00	NO	$0.00	YES	$372.00
4A1A	0.16	3393	0.03	40	0.077	0	1	$0.00	YES	$65.11	NO	$0.00
12C1	0.62	3393	0.00	161	0.306	0	1	$0.00	NO	$0.00	NO	$0.00
12B1	0.31	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
11D1	0.78	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
11A1	0.31	3393	0.00	81	0.153	0	1	$0.00	NO	$0.00	NO	$0.00
10B1	6.20	3393	0.00	1612	3.063	0	7	$0.00	NO	$0.00	NO	$0.00
10A1	0.62	3393	0.12	400	0.759	0	0	$0.00	NO	$0.00	YES	$372.00
9B1	0.62	3393	0.12	400	0.759	0	0	$0.00	NO	$0.00	YES	$372.00
9A5	0.62	3393	0.12	400	0.759	0	0	$0.00	NO	$0.00	YES	$372.00
9A6	0.47	3393	0.09	300	0.570	0	0	$0.00	YES	$65.11	NO	$0.00
9C1	0.08	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
8D1	1.24	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
10E1	4.03	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
9E2	0.08	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
9F2	0.62	3393	0.12	400	0.759	0	0	$0.00	NO	$0.00	YES	$372.00
9O3	0.36	3393	0.07	230	0.436	0	0	$0.00	NO	$0.00	YES	$372.00
10F1	0.31	3393	0.06	200	0.380	0	0	$0.00	YES	$65.11	NO	$0.00
10F2	0.31	3393	0.06	200	0.380	0	0	$0.00	YES	$65.11	NO	$0.00
11F1	0.09	3393	0.02	57	0.109	0	0	$0.00	YES	$65.11	NO	$0.00
14E2	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
15E1	2.33	3393	0.00	605	1.149	0	3	$0.00	NO	$0.00	NO	$0.00
15F2	1.24	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
14F2	0.31	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
15F1	0.31	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
4F1	0.31	3393	0.06	200	0.380	0	0	$0.00	YES	$65.11	NO	$0.00
				6924.308						$455.77		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 363LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 363

% Unnoc. lights: 19%
Gas Increase Factor 1.90E-03 MBtu/kWh
Cooling Factor (Energy) 0

Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches: No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
13F1	2.02	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
13F2	0.08	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
12F3	0.62	3393	0.12	400	0.759	0	0	$0.00	NO	$0.00	YES	$372.00
12F4	0.62	3393	0.12	400	0.759	0	0	$0.00	NO	$0.00	YES	$372.00
12F1	0.16	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
12D1	1.86	3393	0.00	0	0.000	0	1	$396.17	NO	$0.00	NO	$0.00
13C1	1.71	3393	0.00	0	0.000	0	1	$396.17	NO	$0.00	NO	$0.00
13B1	0.62	3393	0.12	400	0.759	0	0	$0.00	NO	$0.00	YES	$372.00
13C2	2.48	3393	0.00	0	0.000	0	2	$792.34	NO	$0.00	NO	$0.00
13B1A	0.16	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
Total	**147.582**		**5.05609**	**20296.23**	**38.5628**	**0**	**30**	**$1,584.68**		**$2,018.41**		**$8,556.00**

Total $ Expense = $12,159.09

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 21-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 366LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 2

BUILDING NUMBER: 366

Sheet 1 of 1

Schedule #1 M-F 600 to 1900 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
1	8	4x2-2 lamp fluorescent	off	yes	no	1	no
2	4	4x2-4 lamp fluorescent	off	yes	no	1	no
3	1	4x2-2 lamp fluorescent	off	yes	yes	1	no
2	6	4x2-2 lamp fluorescent	off	yes	no	1	no
4	8	4x2-2 lamp fluorescent	off	yes	no	1	no
5	2	4x2-4 lamp fluorescent	off	yes	yes	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 21-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 366LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 366

Sheet 1 of 1

% Unnoc. lights: 19%
Gas Increase Factor 1.90E-03 MBtu/kWh
Cooling Factor (Energy) 1

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
1	0.71	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
2	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
3	0.09	3393	0.02	57	0.109	57	0	$0.00	YES	$75.00	NO	$0.00
2	0.53	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
4	0.71	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
5	0.31	3393	0.06	200	0.380	200	0	$0.00	YES	$75.00	NO	$0.00
Total	**2.977**		**0.07581**	**257.2233**	**0.48872**	**257.2233**	**0**	**$0.00**		**$150.00**		**$0.00**
				Total $ Expense =		**$150.00**						

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 400LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 10

BUILDING NUMBER: 400

Sheet 1 of 1

Schedule #1	M-F	600 to	1900	S-S	600 to	1300	
Schedule #2	M-F	0 to	0	S-S	0 to	0	

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
Rec.Rm	31	4x2-4 lamp fluorescent	on	yes	no	4	yes
Kit	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
Men1	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
Women1	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
O1	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
O2	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
O3	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
Hall-1	4	4x2-2 lamp fluorescent	on	yes	no	2	no
C1	8	4x2-4 lamp fluorescent	off	yes	yes	1	no
Rac.Ball	8	4x2-2 lamp fluorescent	on	yes	no	1	yes
Men2	1	4x2-2 lamp fluorescent	on	yes	no	1	no
Women2	1	4x2-2 lamp fluorescent	off	yes	yes	1	no
Menshwr	1	4x2-2 lamp fluorescent	off	yes	yes	1	no
Wmenshwr	1	4x2-2 lamp fluorescent	off	yes	yes	1	no
Hall-2	3	4x2-2 lamp fluorescent	on	yes	no	1	no
O4	4	4x2-4 lamp fluorescent	on	no	no	0	no
O5	4	4x2-4 lamp fluorescent	on	no	no	0	no
O6	4	4x2-4 lamp fluorescent	on	no	no	0	no
O7	4	4x2-4 lamp fluorescent	on	no	no	0	no
O8	8	4x2-4 lamp fluorescent	on	no	no	0	no
O9	13	4x2-4 lamp fluorescent	on	no	no	0	no
O10	4	4x2-4 lamp fluorescent	on	no	no	0	no
C2	8	4x2-4 lamp fluorescent	on	no	no	0	no
S1	8	4x2-4 lamp fluorescent	on	no	no	0	no
S2	4	4x2-4 lamp fluorescent	on	no	no	0	no
C3	1	4x2-4 lamp fluorescent	on	no	no	0	no
Rballhall	4	4x2-2 lamp fluorescent	on	no	no	0	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 400LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 400

% Unnoc. lights: 19%
Gas Increase Factor 2.20E-04 MBtu/kWh
Cooling Factor (Energy) 1.19

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
Rec.Rm	4.80	4121	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
Kit	0.31	4121	0.06	243	0.053	289	0	$0.00	YES	$65.11	NO	$0.00
Men1	0.31	4121	0.06	243	0.053	289	0	$0.00	YES	$65.11	NO	$0.00
Women1	0.31	4121	0.06	243	0.053	289	0	$0.00	YES	$65.11	NO	$0.00
O1	0.31	4121	0.06	243	0.053	289	0	$0.00	YES	$65.11	NO	$0.00
O2	0.31	4121	0.06	243	0.053	289	0	$0.00	YES	$65.11	NO	$0.00
O3	0.62	4121	0.12	485	0.107	578	0	$0.00	NO	$0.00	YES	$372.00
Hall-1	0.36	4121	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
C1	1.24	4121	0.24	971	0.214	1155	0	$0.00	NO	$0.00	YES	$372.00
Rac.Ball	0.71	4121	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
Men2	0.09	4121	0.00	23	0.005	28	1	$396.17	NO	$0.00	NO	$0.00
Women2	0.09	4121	0.02	70	0.015	83	0	$0.00	YES	$65.11	NO	$0.00
Menshwr	0.09	4121	0.02	70	0.015	83	0	$0.00	YES	$65.11	NO	$0.00
Wmensh	0.09	4121	0.02	70	0.015	83	0	$0.00	YES	$65.11	NO	$0.00
Hall-2	0.27	4121	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
O4	0.62	4121	0.00	161	0.035	192	1	$396.17	NO	$0.00	NO	$0.00
O5	0.62	4121	0.00	161	0.035	192	1	$396.17	NO	$0.00	NO	$0.00
O6	0.62	4121	0.00	161	0.035	192	1	$396.17	NO	$0.00	NO	$0.00
O7	0.62	4121	0.00	161	0.035	192	1	$396.17	NO	$0.00	NO	$0.00
O8	1.24	4121	0.00	322	0.071	384	2	$792.34	NO	$0.00	NO	$0.00
O9	2.02	4121	0.00	524	0.115	623	3	$1,188.51	NO	$0.00	NO	$0.00
O10	0.62	4121	0.00	161	0.035	192	1	$396.17	NO	$0.00	NO	$0.00
C2	1.24	4121	0.00	322	0.071	384	2	$792.34	NO	$0.00	NO	$0.00
S1	1.24	4121	0.00	322	0.071	384	2	$792.34	NO	$0.00	NO	$0.00
S2	0.62	4121	0.00	161	0.035	192	1	$396.17	NO	$0.00	NO	$0.00
C3	0.16	4121	0.00	40	0.009	48	1	$396.17	NO	$0.00	NO	$0.00
Rballhall	0.36	4121	0.00	93	0.020	110	1	$396.17	NO	$0.00	NO	$0.00
Total	**19.872**		**0.69863**	**5493.354**	**1.20854**	**6537.092**	**18**	**$7,131.06**		**$520.88**		**$744.00**
				Total $ Expense =		**$8,395.94**						

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 401LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 8

BUILDING NUMBER: 401

Sheet 1 of 1

Schedule #1 M-F 600 to 2300 S-S 900 to 2200
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
ENT	1	4x2-2 lamp fluorescent	on	no	no	0	no
1	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
2	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
1	1	4x2-2 lamp fluorescent	on	yes	yes	1	no
3	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
4	4	4x2-2 lamp fluorescent	on	yes	no	1	no
4	2	4x2-4 lamp fluorescent	on	yes	no	1	no
5	14	4x2-2 lamp fluorescent	on	yes	no	1	no
6	2	4x2-2 lamp fluorescent	on	no	no	0	no
7	30	4x2-2 lamp fluorescent	on	yes	no	1	no
8	1	4x2-2 lamp fluorescent	on	yes	no	1	no
8	1	4x2-4 lamp fluorescent	on	yes	no	1	no
9	1	4x2-4 lamp fluorescent	on	yes	no	1	no
10	1	4x2-2 lamp fluorescent	on	yes	no	1	no
10	3	4x2-4 lamp fluorescent	on	yes	no	1	no
LOCKER	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
OLD MECH.	2	4x2-2 lamp fluorescent	on	yes	yes	2	yes
PIN.MACH	6	4x2-2 lamp fluorescent	on	yes	no	1	yes
S1	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
S2	1	4x2-2 lamp fluorescent	on	yes	yes	1	yes
S2	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 401LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

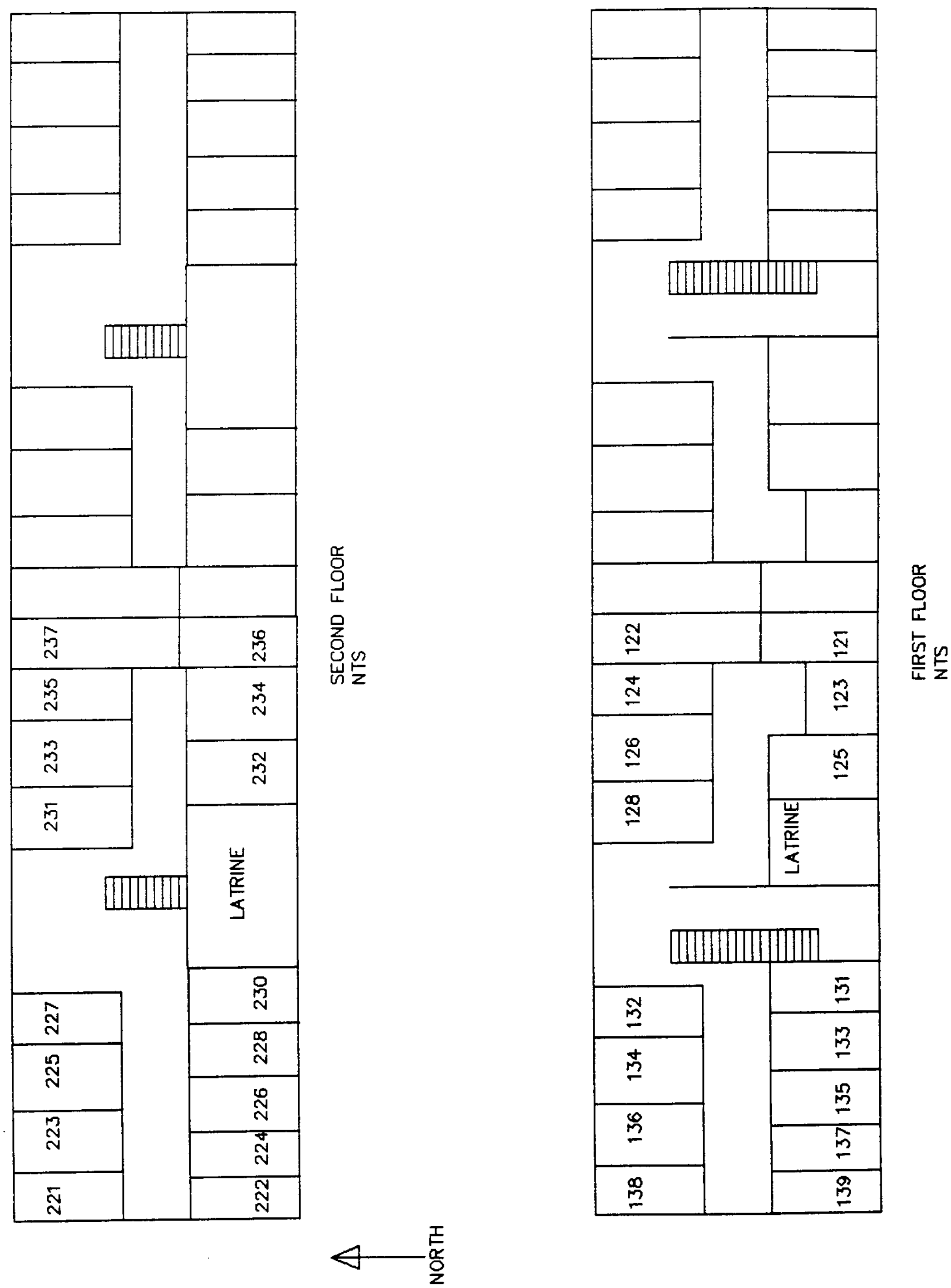
BUILDING NUMBER: 401

Sheet 1 of 1

% Unnoc. lights: 19%
Gas Increase Factor 2.20E-04 MBtu/kWh
Cooling Factor (Energy): 1.19

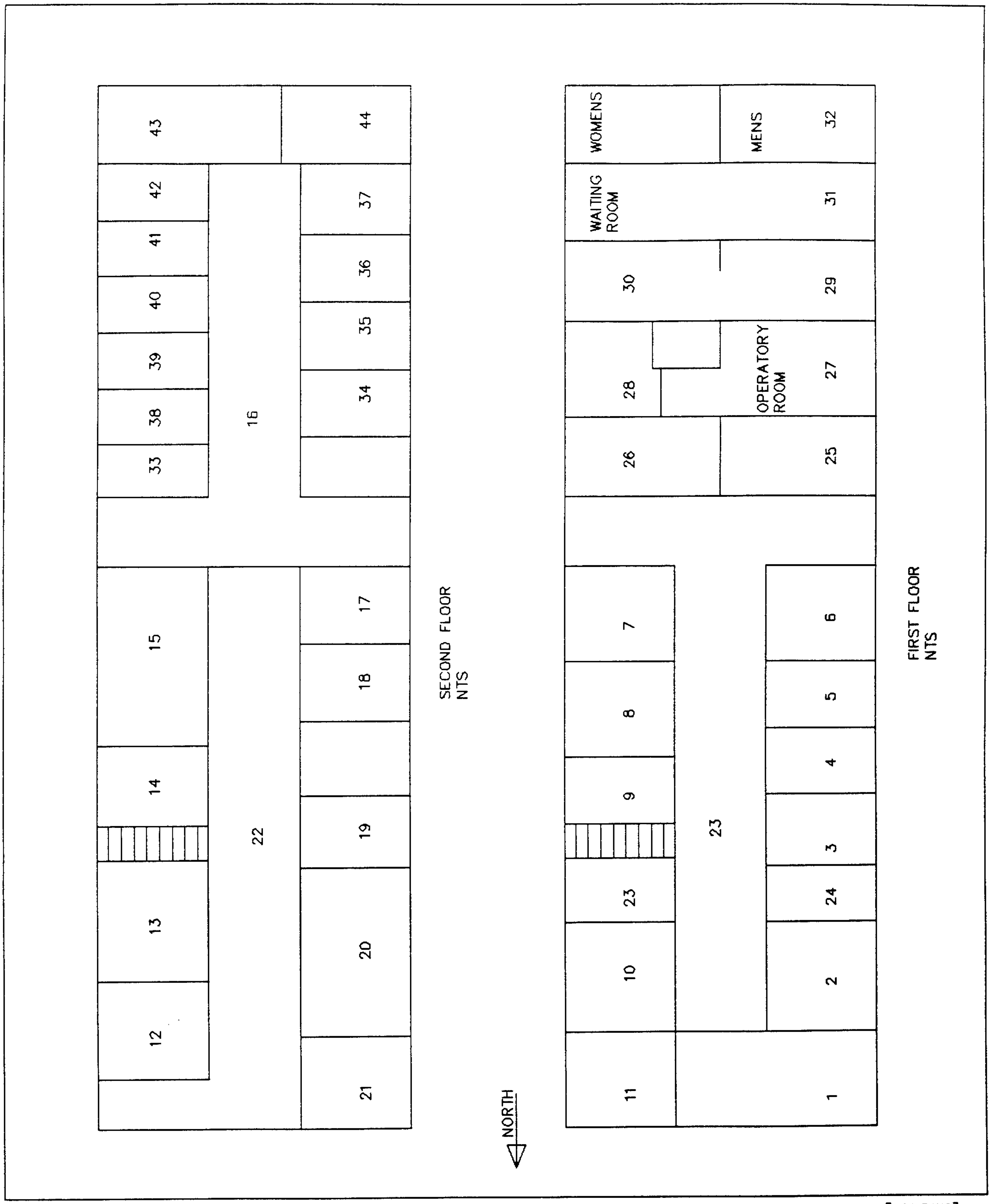
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	Cost of Switches: New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
ENT	0.09	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
1	0.31	5789	0.06	341	0.075	406	0	$0.00	YES	$65.11	NO	$0.00
2	0.31	5789	0.06	341	0.075	406	0	$0.00	YES	$65.11	NO	$0.00
1	0.09	5789	0.02	98	0.022	116	0	$0.00	YES	$65.11	NO	$0.00
3	0.16	5789	0.03	170	0.038	203	0	$0.00	YES	$65.11	NO	$0.00
4	0.36	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
4	0.31	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
5	1.25	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
6	0.18	5789	0.00	46	0.010	55	1	$396.17	NO	$0.00	NO	$0.00
7	2.67	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
8	0.09	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
8	0.16	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
9	0.16	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
10	0.09	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
10	0.47	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
LOCKER	0.09	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
OLD MECH.	0.18	5789	0.03	196	0.043	233	0	$0.00	YES	$65.11	NO	$0.00
PIN.MACH	0.53	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
S1	0.18	5789	0.03	196	0.043	233	0	$0.00	YES	$65.11	NO	$0.00
S2	0.09	5789	0.02	98	0.022	116	0	$0.00	YES	$65.11	NO	$0.00
S2	0.18	5789	0.03	196	0.043	233	0	$0.00	YES	$65.11	NO	$0.00
Total	**7.912**		**0.28253**	**1681.85**	**0.37001**	**2001.397**	**1**	**$396.17**		**$520.88**		**$0.00**
				Total $ Expense =		**$917.05**						

EMC PROJECT # 3105.000
SHEET __ OF __
FT. MC PHERSON BLDG. 58



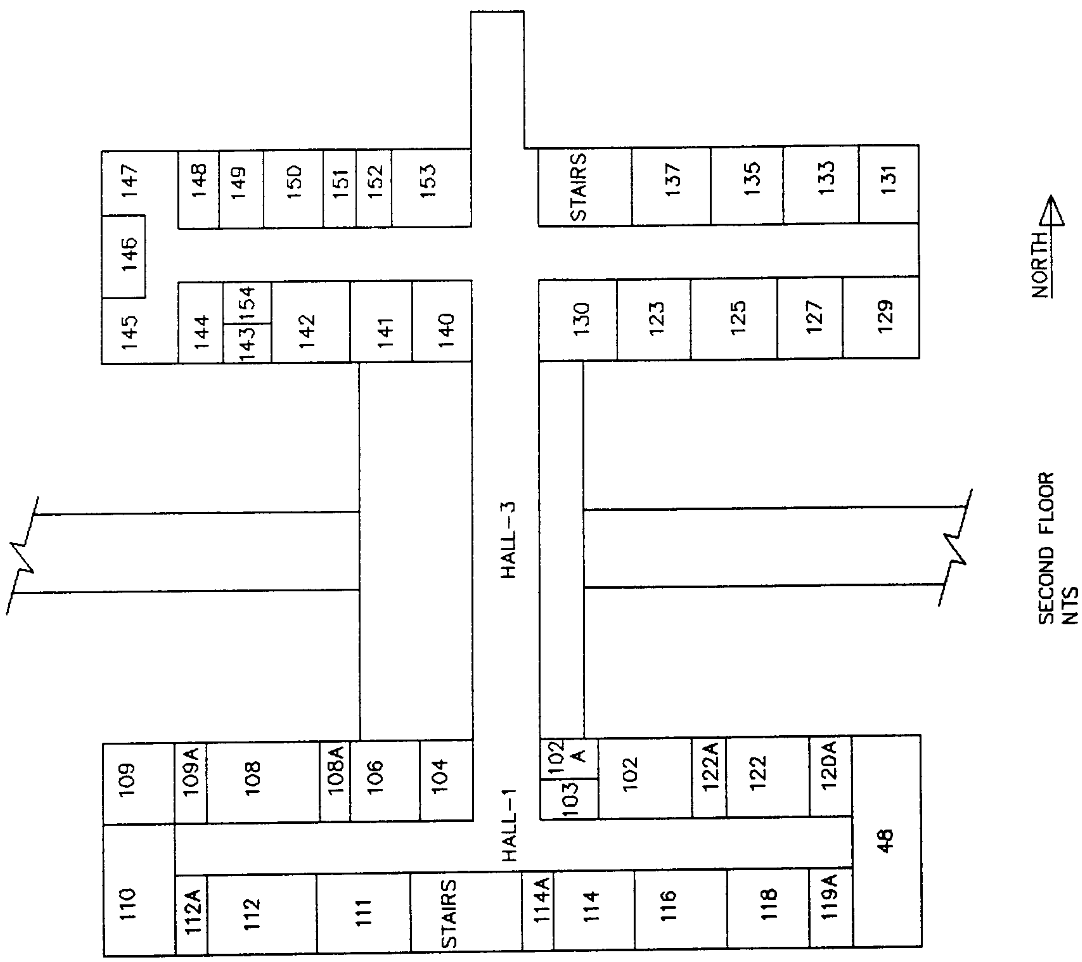
[58.DWG]

EMC PROJECT # 3105.000
SHEET ___ OF ___
FT. MC PHERSON BLDG. 101



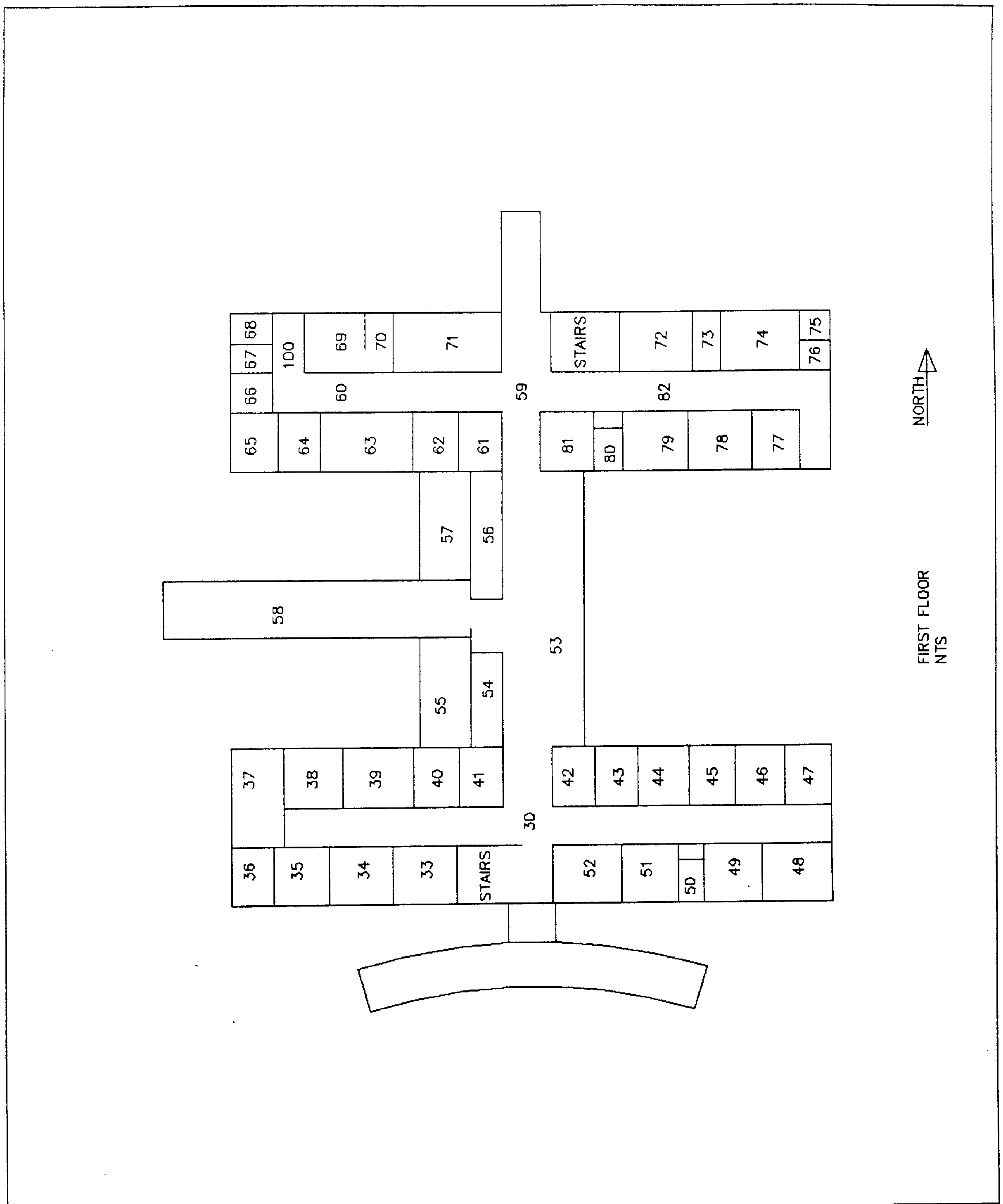
[101.DWG]

EMC PROJECT # 3105.000
SHEET ___ OF ___
FT. MC PHERSON BLDG. 170



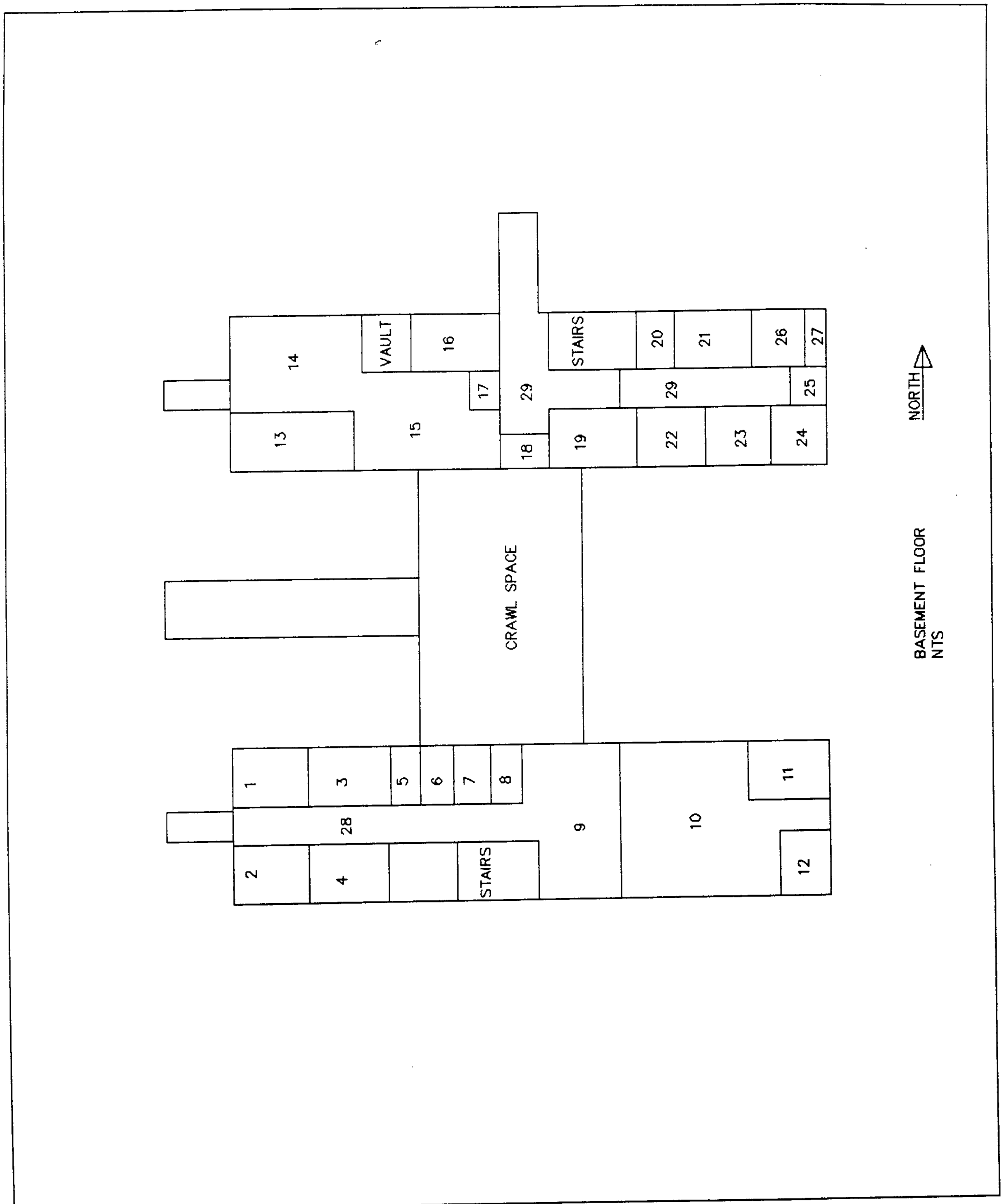
[170_2ND.DWG]

EMC PROJECT # 3105.000
SHEET ___ OF ___
FT. MC PHERSON BLDG. 170



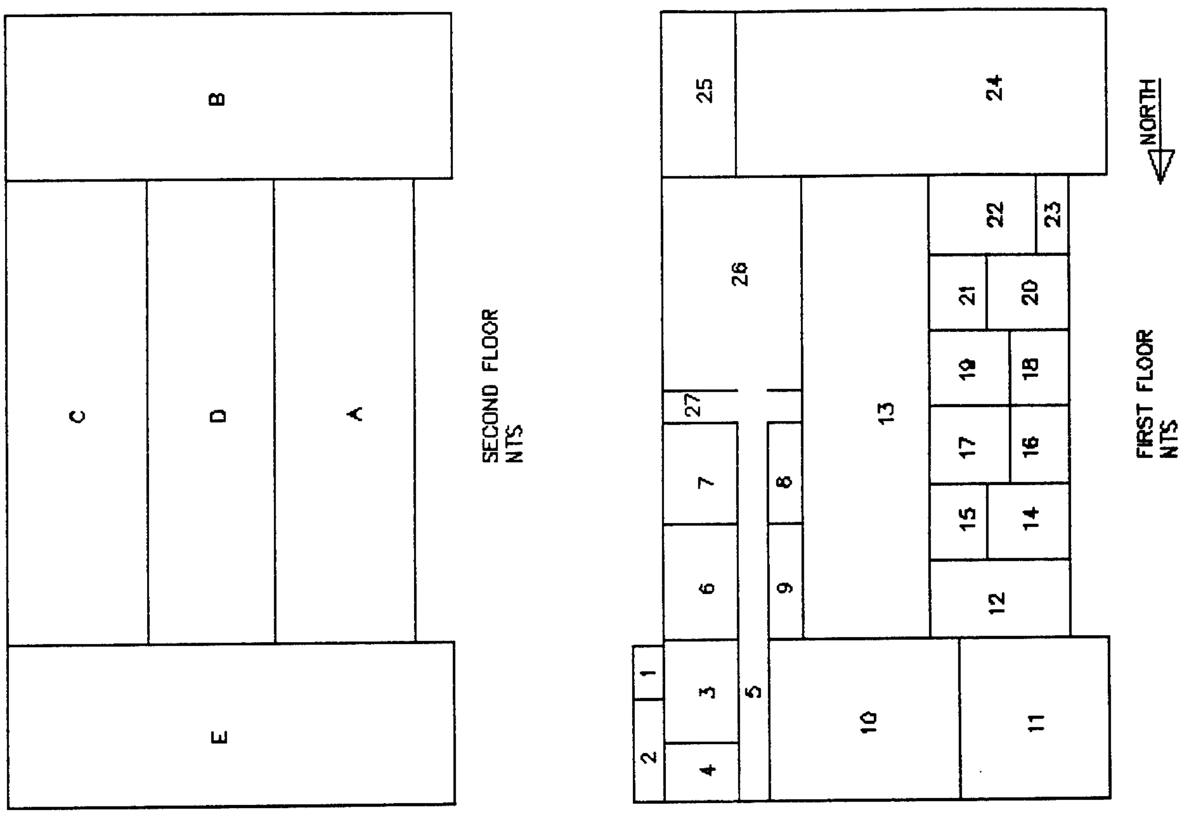
[170_1ST.DWG]

EMC PROJECT # 3105.000
SHEET __ OF __
FT. MC PHERSON BLDG. 170



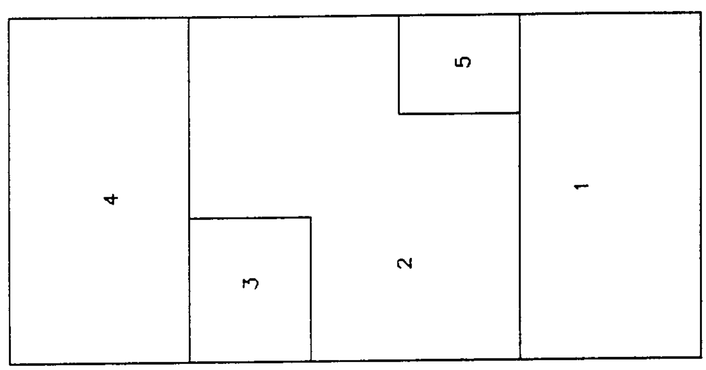
[170_BASE.DWG]

EMC PROJECT # 3105.000
SHEET __ OF __
FT. MC PHERSON BLDG. 184



[184.DWG]

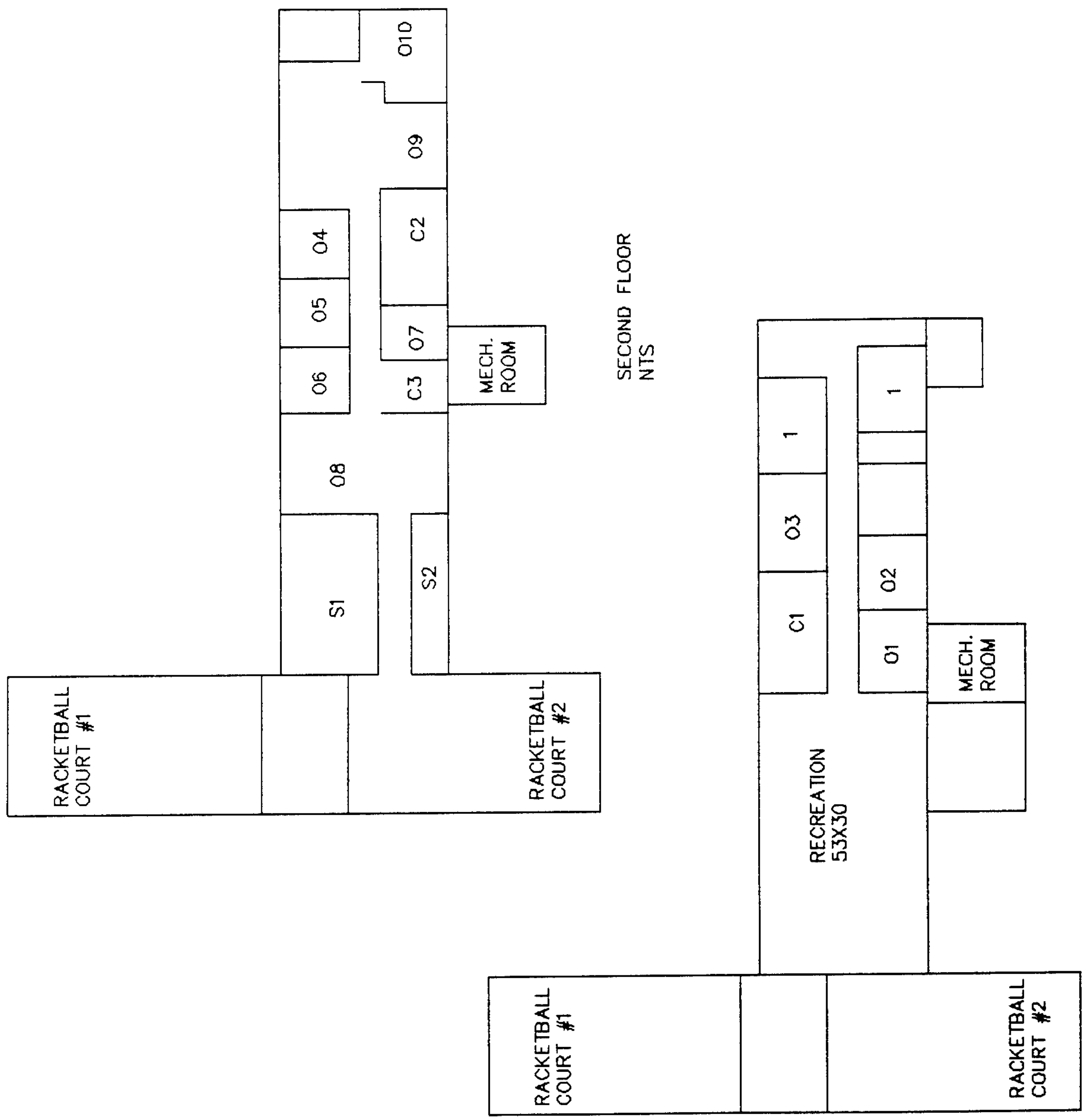
EMC PROJECT # 3105.000
SHEET __ OF __
FT. MC PHERSON BLDG. 366



FLOOR PLAN
NTS

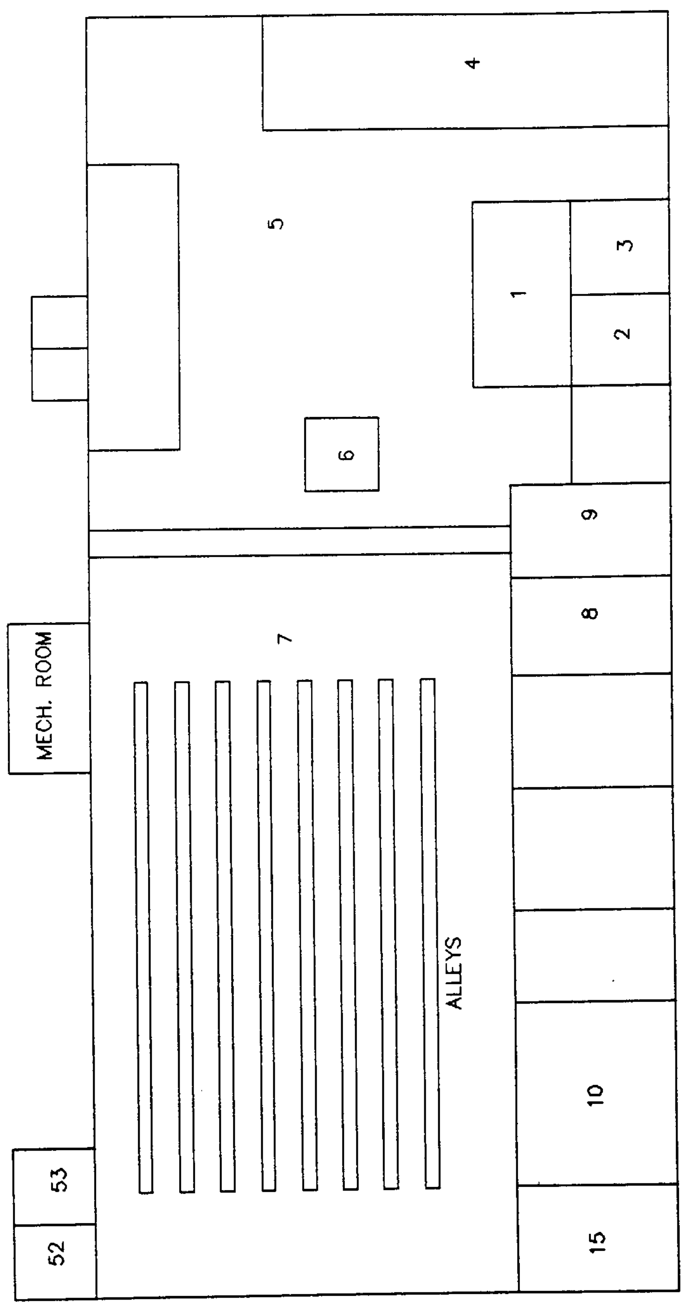
[366.DWG]

EMC PROJECT # 3105.000
SHEET __ OF __
FT. MC PHERSON BLDG. 400



[400.DWG]

EMC PROJECT # 3105.000
SHEET __ OF __
FT. MC PHERSON BLDG. 401



FLOOR PLAN
NTS

[401.DWG]

APPENDIX C-16

INVESTIGATE POST DEMAND USAGE

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: MECO15
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.065
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-16 FM RADIO CONTROL
ANALYSIS DATE: 09-02-92 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	73527.
B. SIOH	$	4044.
C. DESIGN COST	$	4412.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	81983.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	0.	$ 0.	11.11	0.
B. DIST	$ .00	0.	$ 0.	14.26	0.
C. RESID	$ .00	0.	$ 0.	16.89	0.
D. NAT G	$ 4.67	0.	$ 0.	14.45	0.
E. COAL	$ .00	0.	$ 0.	11.21	0.
F. TOTAL		0.	$ 0.		$ 0.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 21983.
(1) DISCOUNT FACTOR (TABLE A) 10.59
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 232800.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 232800.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 0.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) .00
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 21983.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 232800.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 2.84
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 3.73

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 17-Apr-92
FILE: MACELEC.WK3
PREPARED BY: CMD
CHECKED BY: CEL

JANUARY (POSTWIDE)

DECIMAL TIME	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	AVERAGE WEEKDAY	AVERAGE WEEKEND
1.0	2981	3089	3218	2975	3029	3289	3386	3120	3183.5
2.0	2916	3110	3181	2965	3019	3305	3413	3116	3164.5
3.0	2884	3089	3089	2911	2975	3299	3397	3072.6	3140.5
4.0	2894	3143	3121	2938	2981	3321	3467	3100.8	3180.5
5.0	2938	3596	3596	3159	3316	3888	3650	3511	3294
6.0	3445	4255	4142	3699	3872	4282	3710	4050	3577.5
7.0	3364	4801	4628	4244	4390	4887	3866	4590	3615
8.0	3424	5476	5427	5114	5108	5659	3872	5356.8	3648
9.0	3413	5665	5492	5265	5308	5913	3769	5528.6	3591
10.0	3451	5675	5405	5281	5378	5864	3656	5520.6	3553.5
11.0	3510	5567	5335	5330	5378	5805	3650	5483	3580
12.0	3542	5432	5341	5400	5368	5702	3629	5448.6	3585.5
13.0	3532	5389	5303	5346	5351	5578	3569	5393.4	3550.5
14.0	3569	5324	5319	5341	5357	5465	3559	5361.2	3564
15.0	3262	5222	5249	5297	5308	5351	3461	5285.4	3361.5
16.0	3224	4990	4973	5060	5076	5011	3445	5022	3334.5
17.0	3116	4304	4342	4396	4439	4352	3353	4366.6	3234.5
18.0	3159	4001	4039	4201	4250	4115	3348	4121.2	3253.5
19.0	3159	4001	4034	4169	4217	4190	3402	4122.2	3280.5
20.0	3240	3688	3672	3672	3866	3899	3472	3759.4	3356
21.0	3213	3580	3607	3456	3737	3904	3451	3656.8	3332
22.0	3386	3526	3407	3213	3607	3607	3424	3472	3405
23.0	3202	3434	3170	3127	3418	3391	3337	3308	3269.5
24.0	3224	3283	2997	3040	3272	3402		3198.8	1612

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 17-Apr-92
FILE: MACELEC.WK3
PREPARED BY: CMD
CHECKED BY: CEL

JANUARY (BLDG. 200)

DECIMAL TIME	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	AVERAGE WEEKDAY	AVERAGE WEEKEND
1.0	1404.0	1377.0	1323.0	1332.0	1323.0	1408.5	1318.5	1351.8	1361.25
2.0	1395.0	1363.5	1413.0	1318.5	1413.0	1395.0	1381.5	1380.6	1388.25
3.0	1314.0	1308.5	1435.5	1485.0	1435.5	1359.0	1336.5	1395.7	1325.25
4.0	1399.5	1417.5	1413.0	1467.0	1413.0	1417.5	1318.5	1422	1359
5.0	1390.5	1485.0	1489.5	1723.5	1489.5	1503.0	1422.0	1515.6	1406.25
6.0	1296.0	1795.5	1782.0	1827.0	1782.0	1863.0	1341.0	1696.5	1318.5
7.0	1323.0	1822.5	1917.0	1980.0	1917.0	1971.0	1485.0	1791.9	1404
8.0	1710.0	2209.5	1593.0	2286.0	1593.0	2061.0	1615.5	1878.3	1662.75
9.0	1521.0	2065.5	2137.5	2241.0	2137.5	2079.0	1620.0	2020.5	1570.5
10.0	1386.0	2128.5	2025.0	2155.5	2025.0	2106.0	1386.0	1944	1386
11.0	1309.5	2119.5	2254.5	2124.0	2254.5	2290.5	1467.0	2012.4	1388.25
12.0	1314.0	2367.0	1840.5	2128.5	1840.5	2092.5	1359.0	1898.1	1336.5
13.0	1345.5	2160.0	1984.5	2128.5	1984.5	2218.5	1386.0	1920.6	1365.75
14.0	1363.5	2128.5	2308.5	2191.5	2308.5	2173.5	1372.5	2060.1	1368
15.0	1458.0	2097.0	2250.0	2106.0	2250.0	2232.0	1413.0	2032.2	1435.5
16.0	1341.0	2074.5	2160.0	2178.0	2160.0	1989.0	1476.0	1982.7	1408.5
17.0	1399.5	1971.0	1795.5	1885.5	1795.5	1858.5	1458.0	1769.4	1428.75
18.0	1269.0	1741.5	1899.0	1764.0	1899.0	1840.5	1435.5	1714.5	1352.25
19.0	1435.5	1795.5	1854.0	1692.0	1854.0	1683.0	1341.0	1726.2	1388.25
20.0	1413.0	1782.0	1651.5	1674.0	1651.5	1611.0	1458.0	1634.4	1435.5
21.0	1332.0	1764.0	1723.5	1755.0	1723.5	1534.5	1323.0	1659.6	1327.5
22.0	1417.5	1426.5	1444.5	1682.5	1444.5	1413.0	1422.0	1483.1	1419.75
23.0	1300.5	1417.5	1435.5	1372.5	1435.5	1327.5	1300.5	1392.3	1300.5
24.0	1413.0	1228.5	1476.0	1228.5	1300.5	1237.5		1329.3	706.5

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

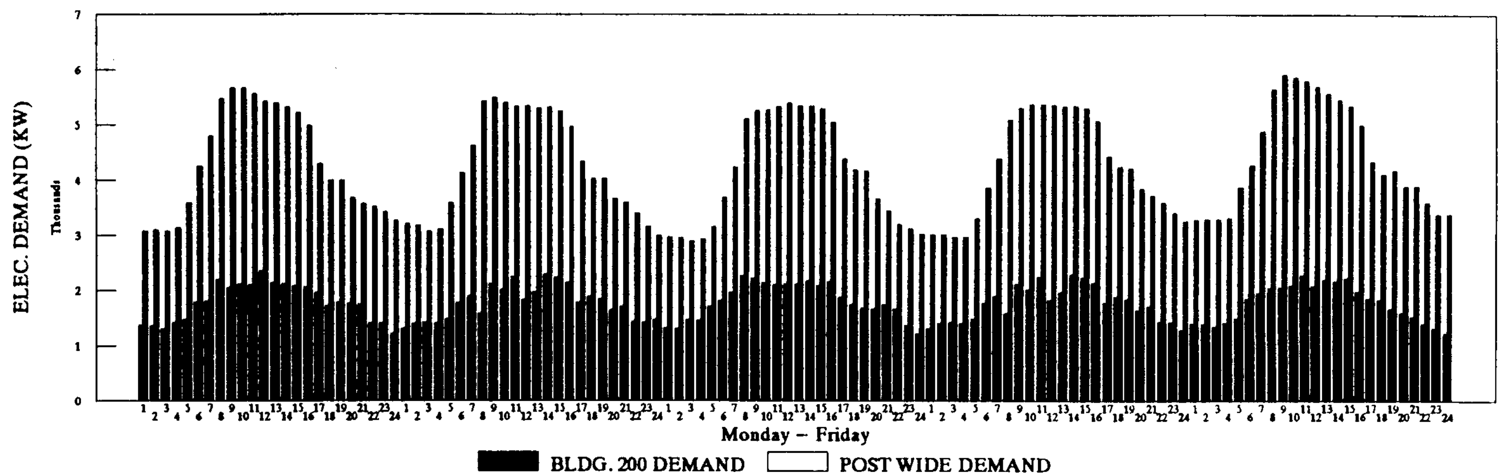
EMC PROJECT: #3105.(
DATE: 17-Apr-92
FILE: MACELEC.WK3
PREPARED BY: CMD
CHECKED BY: CEL

JULY (POSTWIDE)

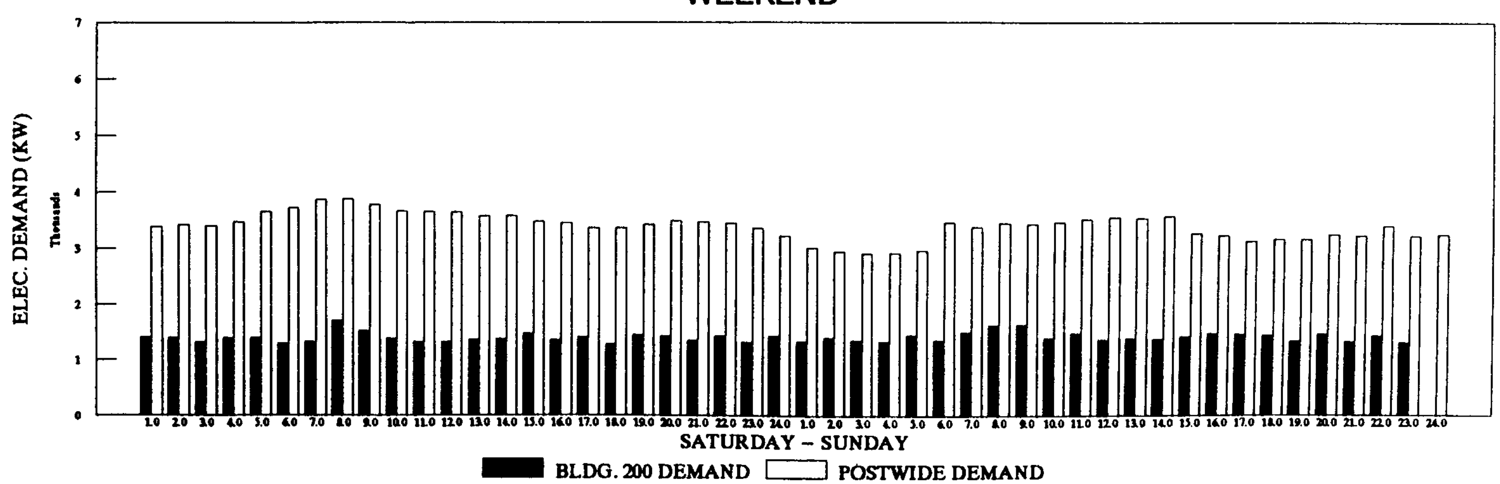
DECIMAL TIME	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	AVERAGE WEEKDAY	AVERAGE WEEKEND
1.0	3748	3710	4158	4282	4039	4244	4234	4086.6	3991
2.0	3672	3775	4077	4315	4072	4309	4180	4109.6	3926
3.0	3580	3818	4158	4406	4185	4396	4115	4192.6	3847.5
4.0	3607	4077	4563	4801	4374	4655	4180	4494	3893.5
5.0	4045	4633	5060	5346	5022	5297	4633	5071.6	4339
6.0	4045	5081	5454	5773	5265	5702	4687	5455	4366
7.0	4093	6097	6529	6637	6426	6707	4833	6479.2	4463
8.0	4180	6502	6901	6944	6788	7079	5152	6842.8	4666
9.0	4271	6658	7182	7160	7063	7301	5357	7072.8	4814
10.0	4520	6982	7398	7393	7349	7376	5589	7299.6	5054.5
11.0	4282	7112	7484	7555	7511	7452	5708	7422.8	4995
12.0	4282	7236	7528	7668	7641	7544	5810	7523.4	5046
13.0	4385	7247	7733	7744	7830	7587	5368	7628.2	4876.5
14.0	4568	7425	7798	7792	7862	7598	5346	7695	4957
15.0	4590	7187	7614	7717	7722	7355	5351	7519	4970.5
16.0	4628	6480	6853	6847	6475	6707	5314	6672.4	4971
17.0	4606	6210	6496	5935	6399	6356	5243	6279.2	4924.5
18.0	4520	5481	5746	5422	5702	5616	5076	5593.4	4798
19.0	4315	5254	5497	5092	5357	5373	4963	5314.6	4639
20.0	4190	5189	5405	4957	5276	5152	4936	5195.8	4563
21.0	4196	4865	5076	4622	5168	5184	4925	4983	4560.5
22.0	4147	4671	4860	4374	4946	4817	4709	4733.6	4428
23.0	4082	4375	4649	4185	4482	4547	4487	4447.6	4284.5
24.0	3796	4201	4417	4061	4374	4390		4288.6	1898

JANUARY

WEEKDAYS

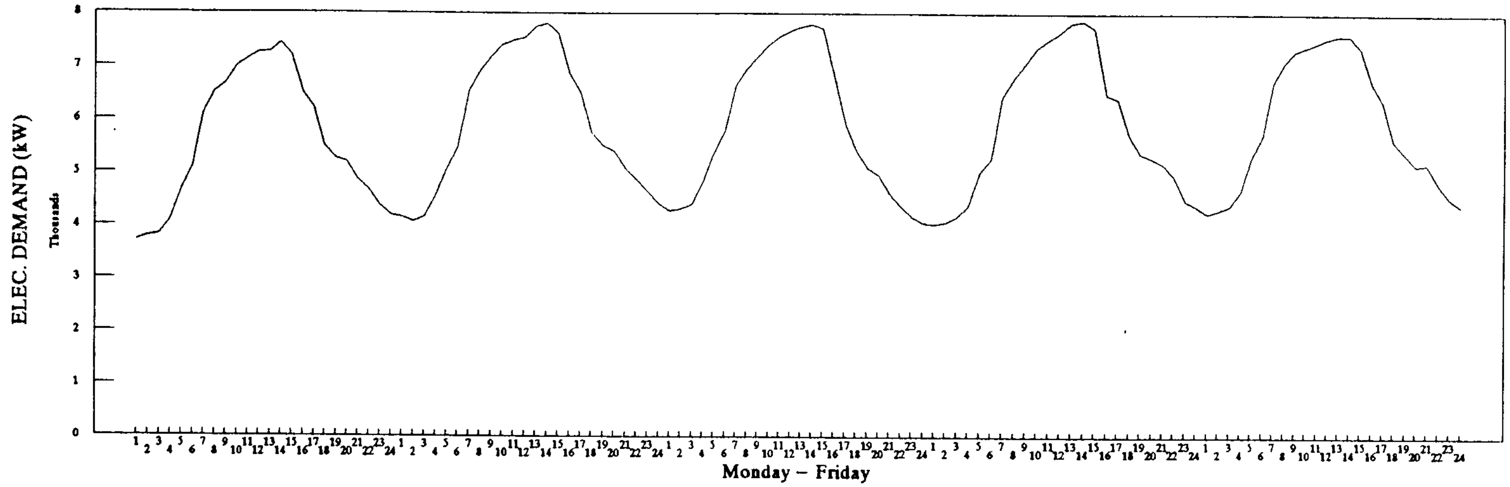


WEEKEND

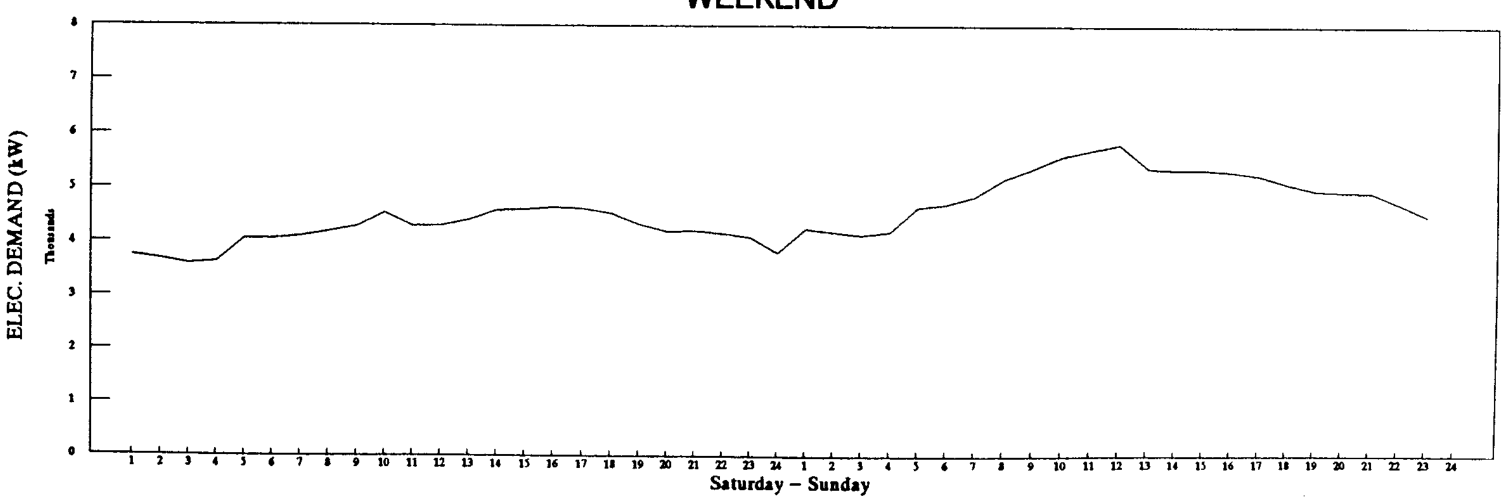


JULY

WEEKDAYS



WEEKEND



Scientific
Atlanta

Control Systems Division – Box 105038 Atlanta GA 30348 Telephone 404 441-4000, TWX 810-766 4912, Telex 0542898, ITT 4611081

April 17, 1992

Mr. Carl Lunstrom
EMC Engineers, Inc.
1950 Spectrum Circle
Suite B-312
Marietta, GA 30067

Dear Carl:

I apologize for the delay in sending you the information you requested recently. We do appreciate your interest in our products, and I really do try to give faster attention to inquiries such as yours. As we discussed, Scientific-Atlanta is a leading manufacturer of radio operated load management systems.

I am enclosing several data sheets to describe a system which would be suitable for Fort McPherson. We can offer a turn-key service to provide and install the head-end equipment, including the transmitter, as well as provide technical support in arranging for installation of the radio switches, which we call DCUs (Digital Control Units). As you know, most military bases would prefer to farm out the labor for installation of these systems.

Budgetary pricing is as follows:

LMC-1041+ Load Management Controller:	$25,000.00
Transmitter and Xtr Controller:	$10,000.00
DCU Radio Switches:	$ 100.00 ea.
Start up and training:	$ 4,000.00
Portable Test Unit:	$ 495.00

I will ask Dick Preston, the regional sales manager for this area, to contact you and provide any further information you may desire. Thanks again for your interest in our products.

Yours truly,

Burns Porter

G. Burns Porter
Applications Engineering Manager

GBP/sjb

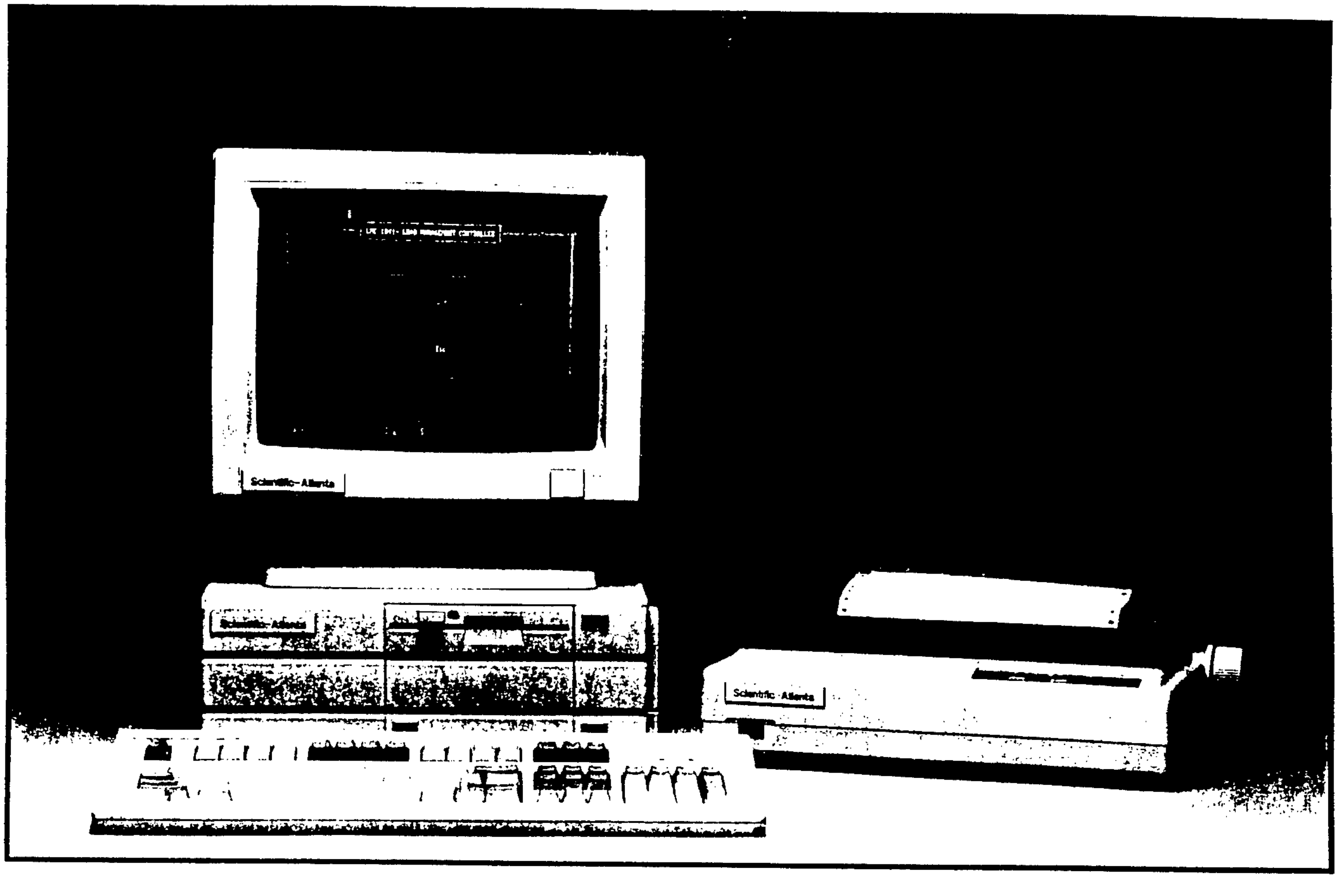
Enclosures

cc: Dick Preston

Scientific Atlanta

Control Systems Division

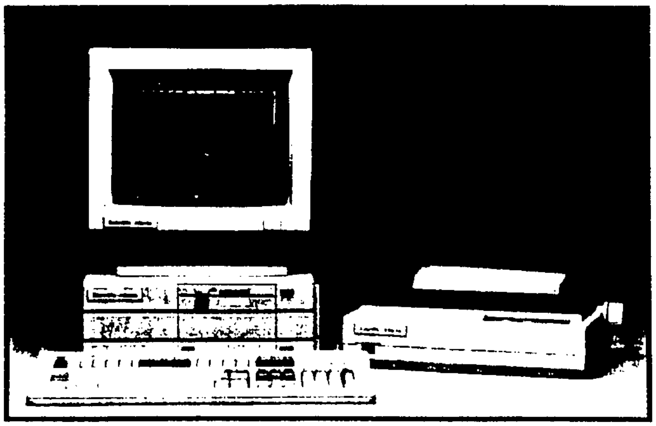
Load Management Controller
Model LMC-1041+



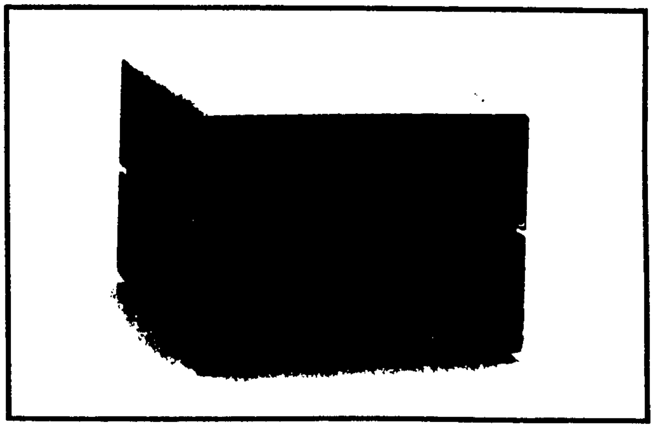
Features

- Combines data acquisition and load control into one machine operating on MS-DOS
- Manual or automatic initiation of load control
- Several load control algorithms are available to the user
- Generates messages in several formats of radio controlled switches
- Program is simple, yet flexible
- Controls air conditioners, water heaters, irrigation pumps, and capacitor banks
- User can define the control "steps" that the program uses
- All programming is done with pop-up menus and operator prompts with on-screen helps
- User defines the number of addresses, number of control groups and strategies he wants and the LMC creates file space to accommodate, limited only by available memory
- Operating characteristics can be modified while the program is running
- Special screens can easily be designed and implemented by the user
- Software supports an optional color monitor
- All software is stored on a hard disk
- Lotus®- compatible historical data files allow easy processing of accumulated data
- Printer can be programmed to automatically print reports
- System automatically restarts in case of power outage
- Interfaces to Scientific-Atlanta's Remote Transmitter Controllers RTC-1032 or RCCA-1002A
- Optional WWV interface ensures accurate timekeeping
- Software supports bar chart and line graphics

Model ***LMC-1041+*** Load Management Controller



LMC 1041+, Load Management Controller



RTC-1032, Remote Transmitter Controller

Description

The LMC-1041+ is a personal computer based load management controller and data acquisition system. Automatic or manual control commands are initiated by the LMC-1041+ to remotely installed radio receivers. The receivers control loads such as air conditioners, water heaters, pool pumps, irrigation pumps, etc. Power factor control is also possible by remotely controlling distribution feeder capacitor banks.

Data acquisition capabilities of the LMC-1041+ permit monitoring of substation data for display and/or initiation of automatic control functions. Automatic control can be done using kW or kVAR inputs, status point closures, and/or time-of-day and day-of-week schedules.

Capable of outputting all standard Scientific-Atlanta code formats as well as a number of others, the LMC-1041+'s flexible software permits the user to easily configure the system by selecting the options he wants from the pop-up menus, lists of valid entries, and notes which briefly explain what each entry does.

An unlimited number of load groups as well as multiple load control algorithms, time-of-day schedules and control strategies provide ultimate flexibility. The user can even modify existing displays or create new displays to meet his needs using the LMC-1041+ display editor. With this capability he can display the most important "real-time" and explanatory information.

The LMC-1041+ places no limit on the number of strategies, load groups, or switch addresses the utility may use. The user tells the LMC what he wants to do and the LMC creates file space to meet the user's needs. The only limit is the amount of memory available.

The LMC-1041+ program is organized by strategies, setpoints, status points and time-of-day schedules. The user can then apply these characteristics to increase or decrease the amount and type of load to be shed and restored to meet changing control requirements. The user can call for load control algorithms such as cycling at a designated percentage, on/off control, various distributed intelligence strategies, nicking or SCRAM. These can be used in virtually any combination to meet the user's control needs.

The LMC-1041+ also has several features which support the user in operating the system and reporting what has happened. All information can be formatted into a Lotus® compatible file and stored on the hard disk. The printer can be programmed to print out any or all events such as alarms or the automatic initiation of load control.

The LMC-1041+ also uses Scientific-Atlanta's Remote Transmitter Controller (RTC-1032) in this system. An RTC-1032 is located at each transmitter site, connected to the LMC through 1200 baud modems. The RTC-1032 (formerly the RCCA-1002A) receives the messages to be broadcast from the LMC, stores those messages until its proper time slot, keys the transmitter, then generates the proper modulation (tones or shifting frequency) to represent the message.

The RTC can generate most of the formats used in load control today. These include single tone, two tone, Scientific-Atlanta's digital, 100, 102, SA-105 and SA-205 AFSK formats, and the Golay 23, 12 FSK format.

The RTC can control up to six groups of transmitters (for time slot coordination with other utilities). If a carrier-operated relay is in the transmitter, the RTC can also wait until the air clears before broadcasting.

The LMC-1041+ is typically quoted with the standard hardware shown in the specifications section. The RTC's and modems are quoted separately because each system may require different numbers of transmitters.

Specifications

LMC-1041+ Hardware

- Personal computer running on MS-DOS operating system with enhanced keyboard and 640K of RAM
- 13" Color Monitor
- 3 1/2" 720K floppy disk drive
- 20 MB hard disk
- Dot matrix printer
- Serial port
- Parallel port
- Data acquisition board and connector panel with 8 analog inputs, 8 status inputs, and 8 contacts out
- All interfaces and cables required
- Hardware Options:
  1. Up to 24 analog inputs, 24 status inputs, and 24 contacts out

LMC-1041+ Software

- **Load control**

  1. ***Strategies***
     a. Up to 1000 allowed
     b. One or more running at the same time
     c. Up to 100 load control steps per strategy
     d. Direction of the steps can be changed whether in shed or restore mode
     e. Strategies can be tied to any combination of four status points, analog demands, or time-of-day schedules for automatic initiation of load control
     f. And/or conditionals enhance initiation factors
     g. Strategy activation can be automatic (tied to activation parameters), continuous (constantly active), or in SCRAM mode (to select 100% shed of all points)
  2. ***Steps***
     a. Three types of steps (activation of switch groups, closing control points, or resetting strategy activation level to a new point)
     b. Automatic, continuous, or SCRAM activation of any step
     c. Steps can be linked to make them happen at the same time in either the shed or restore direction.
     d. Information going to the historical data files can be turned on and off
  3. ***Switch Group Steps***
     a. Switch control algorithms
        - Sequential step (on/off in the same order each time)
        - Rotational step (on/off in rotating order)
        - Gradual time cycle (achieve designated % over one time-out period)
        - Fast time cycle (achieve designated % in one burst of messages)
        - Target % load shed (responds to changes in demand level)
        - Nicking (for testing the effectiveness of load control)
        - 102 commands (repeating direct load control)
        - SA-105 and SA-205 commands (distributed intelligence control)
     b. Maximum load shed % for this switch group
     c. Maximum duration of load control for the switch group
     d. Time that the appliance must remain on after reaching its maximum duration before it can be controlled again
     e. Time-out, cycle time and number of repetitions selections in the 102, SA-105 and SA-205 format switches.
  4. ***Switch Groups***
     a. Up to 1000 addresses per group
     b. Group assigned to a single or all transmitters
     c. Repeat number of messages sent each time (1 or more)
     d. Minimum, nominal, and virtual time-outs
  5. ***Addresses***
     a. Individual addresses can be enabled or disabled
     b. Messages sent can be recorded in a data file
     c. Nine different formats are supported (SA timeout, SA set/reset, single tone, two tone, Golay, 100, 102, SA-105 and SA-205)
  6. ***Time-of-Day Schedules***
     a. Schedule name
     b. Programmed for seven days plus holidays
     c. 4 start/stop intervals per day
  7. ***Holiday Lists***
     a. 20 days
  8. ***Transmit Schedule and System Options***
     a. Enable or disable transmissions during each minute of the hour (for coordination with other utilities)
     b. Time slotting for 1 to 6 transmitter groups (divides the minute into 10 to 60 second time slots)
     c. Carrier busy "listen-before-talk"
     d. Password security
     e. WWV time synchronization

Specifications (Cont.)

- ## Data Acquisition

1. *Remote Terminals*
   a. Individually addressable
   b. Polling can be enabled or disabled
   c. Polling interval in one minute increments
   d. Up to 24 status points
   e. Up to 24 analog-in points

2. *Telemetry (analog inputs)*
   a Default values can be assigned in case of communication failures
   b. Scaling mulitipliers are used
   c. Offsets establish starting points
   d. High and low limits establish use of defaults

3. *Calculate*
   a. Analog values used to calculate demands
   b. Unlimited number of calculations available
   c. 30 different operators can be used

4. *Demands*
   a. Names
   b. Unlimited number
   c. Combines analog inputs in any manner
   d. Demand interval set from 1 to 60 minutes

5. *Setpoints*
   a. User designated initiation factors (kW, kVAR, kVA, temperature, etc.)
   b. User sets shed and restore values
   c. User decides the relationship of the shed and restore values

6. *Control Points*
   a. Name
   b. Up to 24 contacts-out (external)
   c. Unlimited number of internal control points

- ## Reporting

1. *Printer*
   a. Automatic printing of events (alarms and actions)
   b. Automatic printout of special screens at designated times

2. *Display building program*
   a. Used to develop special, custom-built screens

3. *Historical Data Files*
   a. Name
   b. Captures designated display numbers
   c. Establish interval between captures
   d. Establish file sizes
   e. Reset data by day of the month

4. *Graphics*
   a. Explanatory including lines and boxes
   b. Real time bar and line graphs
   c. User choice of colors, intensity, axes and offsets

5. *Transmitter Check-Back*
   a. Error indications from the transmitter sites can alarm at the LMC

- ## Miscellaneous

1. Pop-up bar type menus
2. On-screen programmable helps (lists options at each choice)
3. Programming is done by filling in the blanks
4. Function keys (F1 - F12) are user programmed to enact control or call up screens
5. A majority of programming characteristics can be changed while the program is running
6. Copy configurations to floppy disk
7. Automatic testing for illegal parameters and relationships
8. Redundant hardware configuration allows automatic transfer between machines in case of failure

- ## Options

  - Communications package to allow a remote computer to query, modify the program, or enact control

RTC-1032 Remote Transmitter Controller

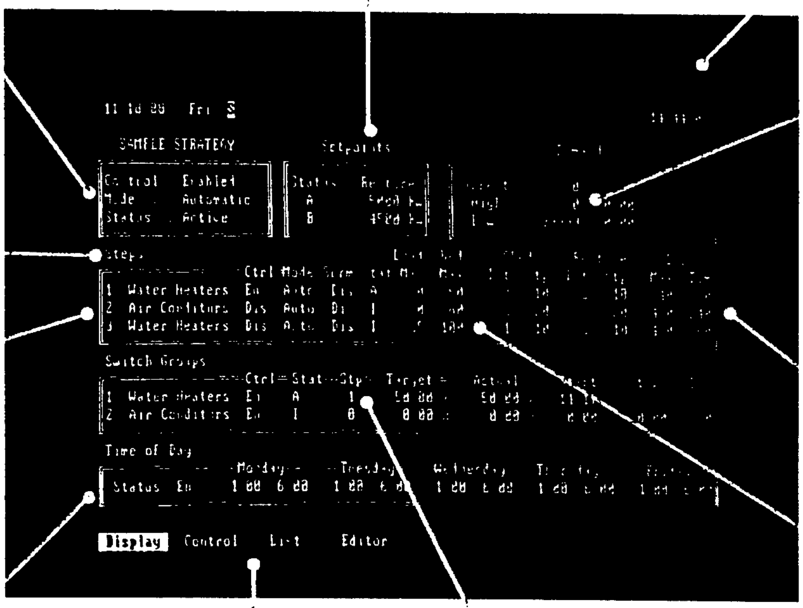
- Input - 120V ac, 60 Hz
- Power Consumption - 30 watts
- Operating temperature 0°C - +50°C
- Control Output - 6 SPST contacts, 250V ac, 3A
- Communications Modem - 1200 baud, bell 212
- Listen-before-talk - contact closure from carrier operated relay in the transmitter with LBT override (if the channel stays busy)
- Status Input - two contact closures

Typical Load Management Program

Control: Can be enabled or disabled from this page.
Mode: Allows automatic or manual operation.
Status: Shows whether control is active or inactive

Status: Indicates current load control activity (shedding or restoring).
A: The demand level at which load control is initiated.
B: The demand level at which the program starts restoring the loads.

This screen was "built" by the user from standard information to display the most important information on a real-time basis.



Current: Total system demand.
High: The high demand (with time) for the current period.
Low: The low demand for the current period.

Steps: Define the order of the procedure for controlling load

Names: The type of load controlled in each step.

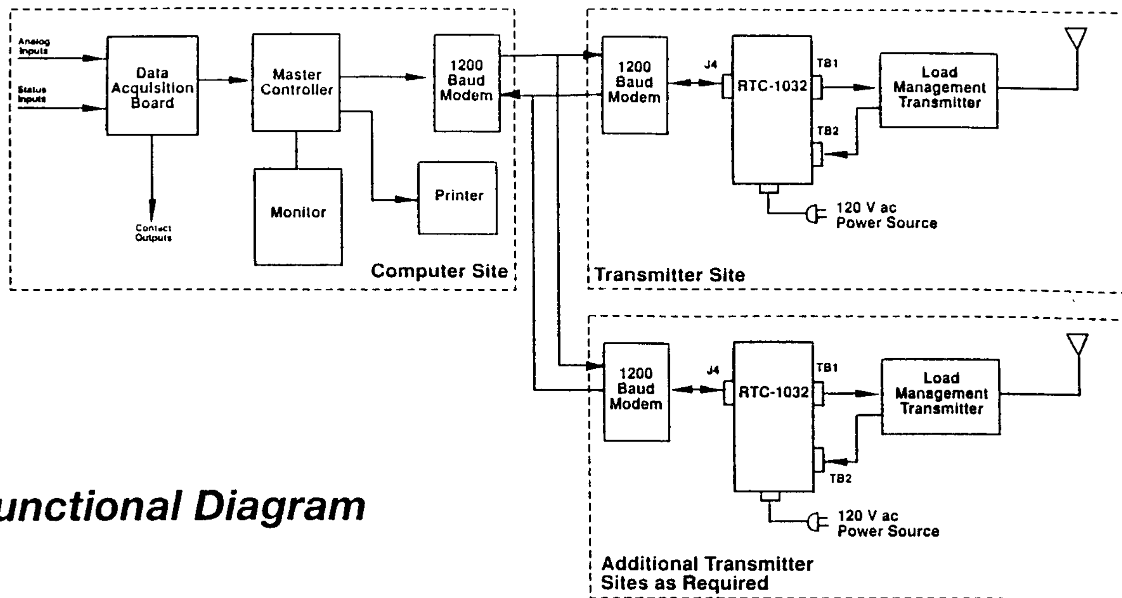
Duration: The maximum and current duration of this step being active.

Load Shed–Min and Max: Sets the limits of load shed percentage for this step.

Time of Day: Shows which days and what time of day this strategy can be active (subject to other setpoint demands and/or contact closures).

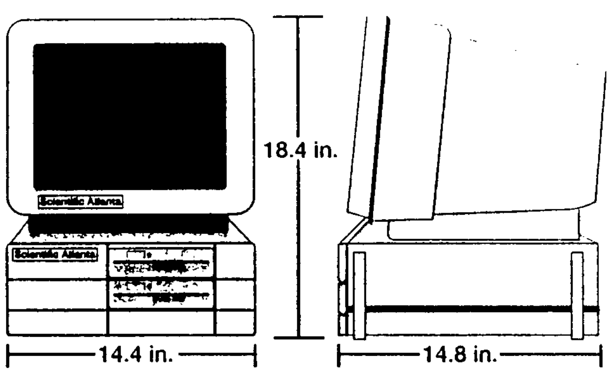
Main Menu: This can be displayed on any page in the run mode by hitting the (ESC) key.

Step: Describes in which step this switch group is currently being used.

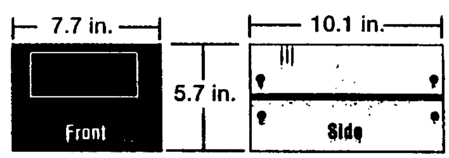


Functional Diagram

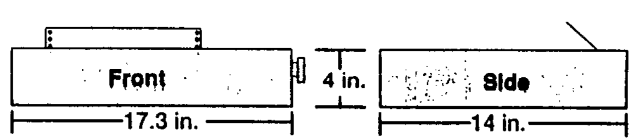
Component Outline Dimensions



Master Station



Remote Transmitter Controller



Printer

Scientific-Atlanta, Inc.

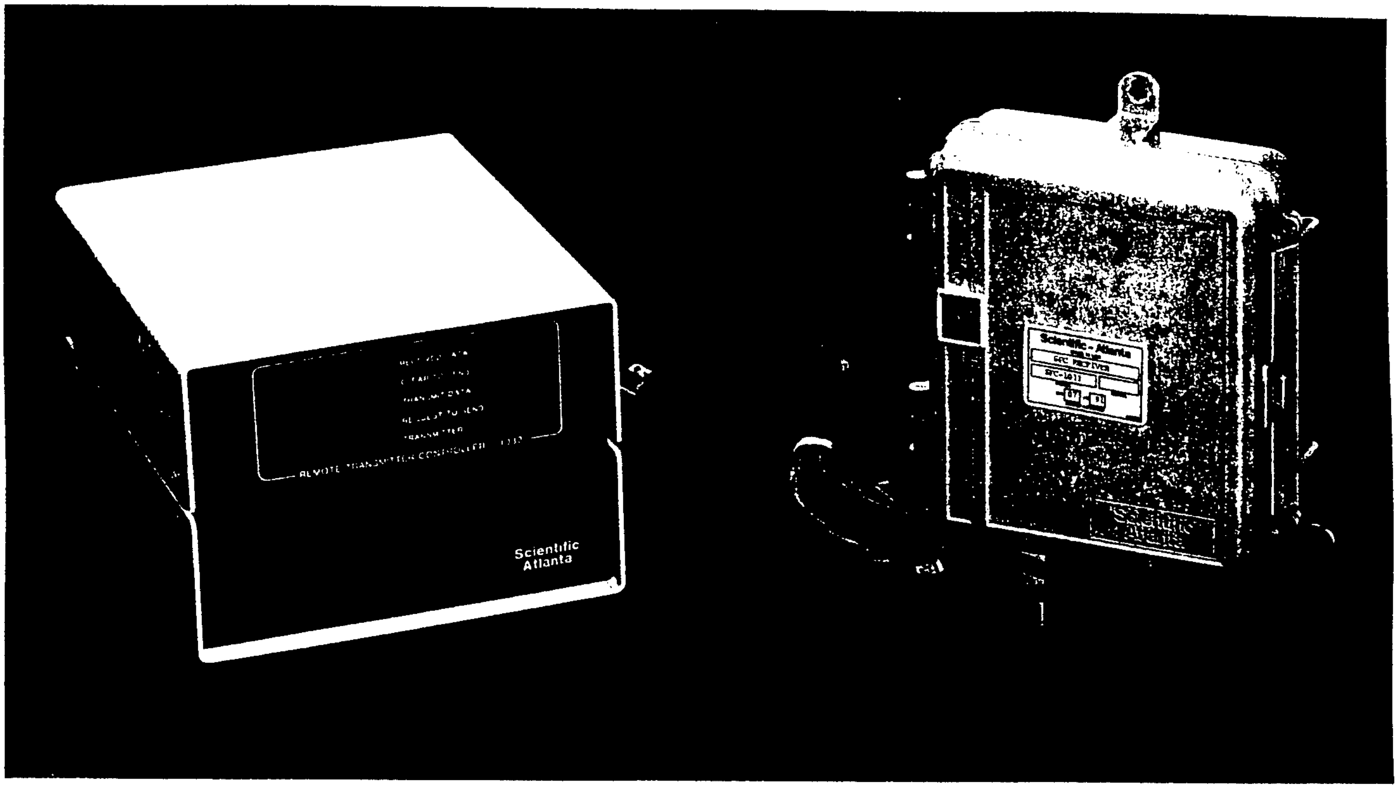
"Our Customers are the winners."

404-449-2900

United States: 4300 Northeast Expressway, Atlanta, GA 30340; FAX 404-449-2931; Telex 0542898

Scientific Atlanta
Instrumentation Group

Transmitter Controllers
Model RTC-1032/SFC-1033



20118

Generates audio messages received from a master controller to activate load management switches for demand control.

Features

- Multiple transmitter control (up to six)
- Capable of seven different VHF message formats
- "Listen-before-talk" option
- Watchdog circuitry
- Power fail detect circuit

Applications

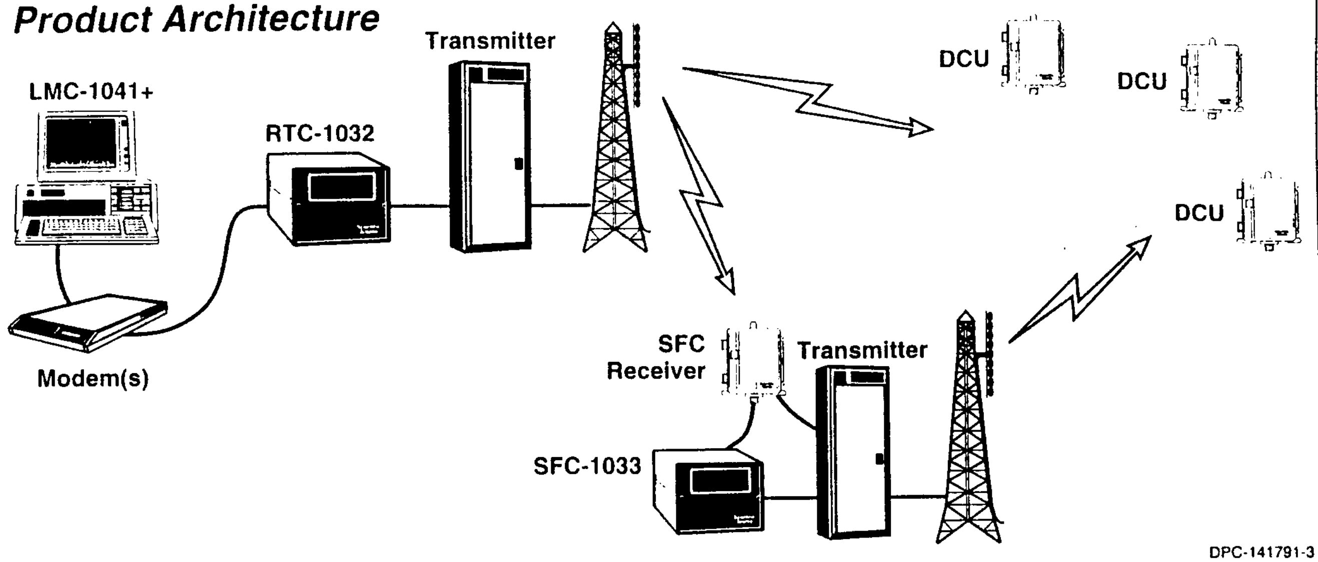
The RTC-1032 Remote Transmitter Controller is capable of generating messages in any of seven code formats to activate load management switches based on data downloaded from a master controller.

The SFC-1033 Store and Forward Controller is identical to the RTC-1032 and is located adjacent to a repeater. The SFC repeats data it has received via the antenna switch relay circuit located in the repeater.

Scientific-Atlanta, Inc.
404-449-2900

Transmitter Controllers
Model RTC-1032/SFC-1033

Product Architecture



Operation

The RTC-1032 receives load control messages and timing messages from a master controller. The RTC-1032 then generates audio tones representing digital messages and keys the transmitter at the appropriate times. The RTC-1032 is capable of receiving and responding to a contact closure for "listen-before-talk" to make sure the channel is free before transmitting. The RTC-1032 contains watchdog circuitry to eliminate lockups of microprocessors caused by transients and power surges.

Two modes of transmissions are provided when using multiple transmitter control. The "slotted mode" divides the minute into as many as six time slots, so that each RTC-1032 keys each transmitter at the appropriate interval. Where a single RTC-1032 is connected to multiple transmitters, the "contiguous mode" keys the transmitters back-to-back with only key up/key down delays between transmissions.

The SFC-1033 receives load control messages and timing messages via the antenna switch relay circuit located in the repeater. The SFC-1033 buffers the data and retransmits it, acting just like the RTC-1032. The SFC-1033 will generate the digital messages and key the transmitter/repeater at the appropriate times. The SFC-1033 can respond to a contact closure for "listen-before-talk" to make sure the channel is clear before transmitting. The SFC-1033 also contains the watchdog circuitry.

The SFC-1033 can control multiple transmitters located at a central remote location by tieing into just one of the receivers. Several SFC-1033s can be used within a system but one RTC-1032 is required at the main transmitter.

The RTC/SFC can generate the following formats:

Single-tone	Two tone sequential
SA Digital	Golay 23.12d
REMS 100/102	SA-105
SA-205	

Specifications

Enclosure
Aluminum
Size
7.7 in. W x 5.7 in. H x 9.1 in. D
Weight
8.5 lbs.
Shipping weight
10 lbs
Input voltage
120V ac, ±10%, 60 Hz
Power consumption
30W max
Operating temperature
0°C to 50°C, non-condensing
Transmittal keying control
6 "SPST" - Normally opened relays rated at
.5A 125V ac
.6A 110V dc

Specifications subject to change without notice

Ordering Information

RTC-1032	Remote Transmitter Controller
SFC-1033	Store and Forward Controller

Scientific-Atlanta, Inc.

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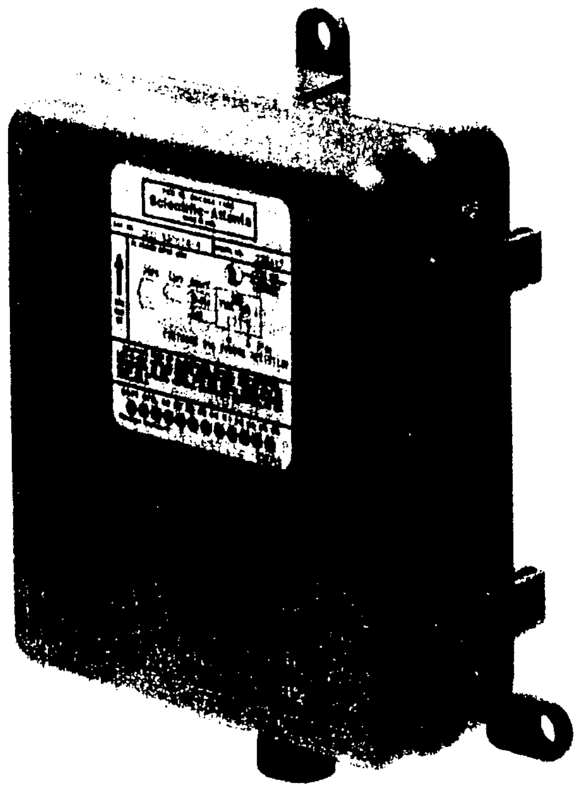
4300 Northeast Expressway, Atlanta, GA 30340 Tel: 404-449-2900 Fax: 404-449-2931

Scientific Atlanta

Control Systems Division

Digital Control Unit
Series DCU-S2000A



The radio controlled switch interrupts loads, such as air conditioners, water heaters and irrigation pumps, upon command from the utility's master controller for load management.

Features

- 4 million individual fixed addresses
- 6 programmable operational addresses per switch can be grouped for divisional, area, substation or feeder control
- Remote programming via radio message
- Choose from 4,096 programmable, operational addresses
- Distributed intelligence design provides up to 8 hours of control with one message
- Randomized "shed" and "restore" provide smooth, graceful ramping in and out of load control
- High performance dual conversion FM receiver
- Cold load pickup and cancel
- A record of actions kept in non-volatile memory, accessible by the Portable Counter Display®
- Fail safe timer reconnects load at the end of the control period
- Weatherproof, Lexan® enclosure
- Electronics mounted in removable door for easy field maintenance
- One, two, three or four separate functions

Description

The SA-205 format Digital Control Unit (DCU) is a radio controlled switch designed to switch remote loads on and off in response to commands from a central control. Additionally, each digital control unit may be individually programmed and controlled remotely via radio signals.

Utilizing "distributed intelligence", control for up to eight hours can be accomplished upon the receipt of a single radio command. A smooth transition into as well as out of control is ensured through the use of a unique, linear control algorithm in which each switch independently selects its own start and stop times after receipt of a radio control message.

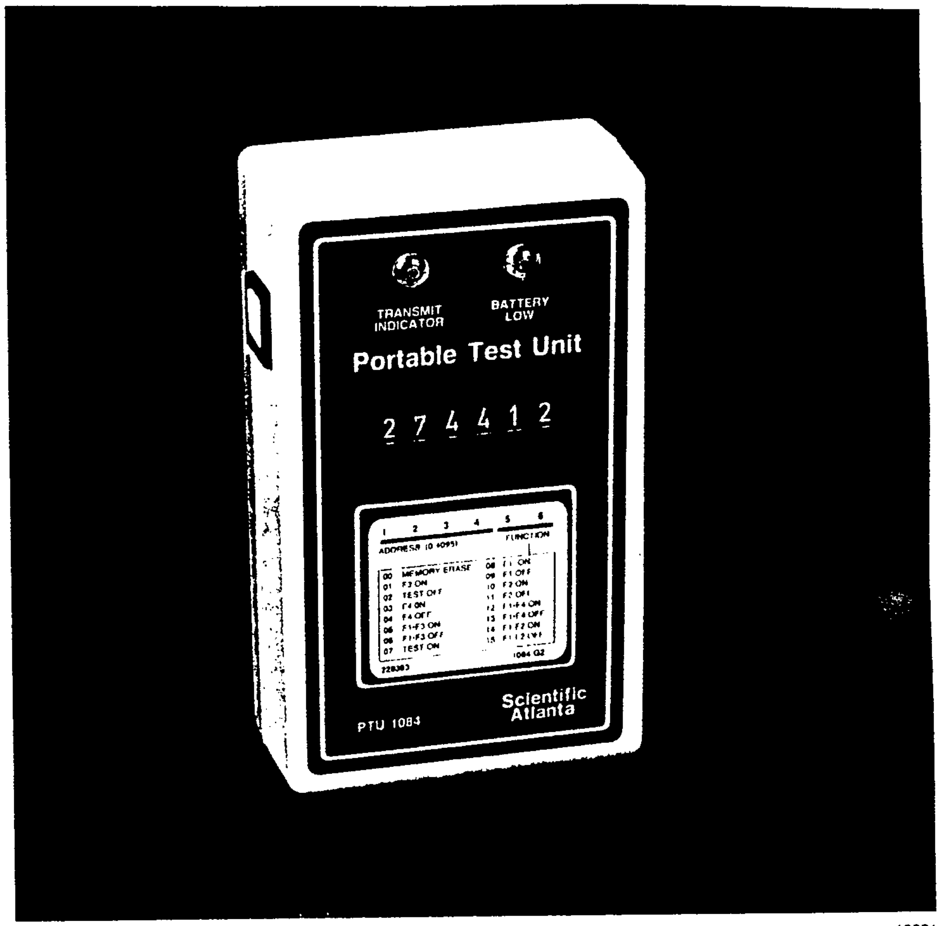
SA-205 Digital Control Units are available in one, two, three or four function designs. Cold load pickup, a feature which disconnects load when power is restored after an outage, is remotely programmable from 0 to 60 minutes via radio message.

Important data about the DCU's operation, including the number of operations, time since its memory was reset and configuration data, is maintained in the unit's memory. Data can be read with a Scientific-Atlanta Portable Counter Display (PCD), without opening the DCU door. The Portable Counter Display transmits a radio signal to the digital control unit which causes the DCU to flash its LEDs in a digital manner. The PCD optically reads the data and displays it on a liquid crystal display.

Scientific
Atlanta
Instrumentation Group

Portable Test Unit
Model PTU-1084/1085

A hand-held device that locally exercises the functionality of a Digital Control Unit.



19921

Features

- Provides on-site testing of radio controlled switches
- Available for use with popular FSK and AFSK code formats
- Powered by replaceable 9V battery
- Low battery indicator
- Includes nylon case

Application

Scientific-Atlanta's PTU-1084/1085 Portable Test Unit is a hand-held, battery operated low output transmitter which permits field testing of Digital Control Units. It allows manual transmission of digital radio signals to test for proper operation of a switch. The economy and portability of the PTU make it practical for each switch to be tested as it is installed.

The PTU-1084/1085 is crystal-controlled and transmits on a customer-specified VHF frequency, between 138 and 174 MHz.

Scientific-Atlanta, Inc.
404-449-2900

GAS AIR CONDITIONING EQUIPMENT

January 14, 1992

ENGINE DRIVEN:

TECOCHILL: 125, 150tons (165tons w/economizer); Teco Drive 454; screw compressor
R22 refrigerant; heat recovery available
(250 and 500 ton models in field test)
Mingledorff's: Bruce Longino, 404-446-6311

TRANE: 55, 80 tons; Hercules engine; Trane reciprocating compressor
Trane: Jim Gieselman, 404-321-7500

THERMO KING: 15ton, 25ton(Summer 1991); rooftop units; Hercules engine;
Thermo King reciprocating compressor; +80% furnace included
Split 15ton system available summer 1991
Thermo King Atlanta, Inc.: Harold Haskell, 404-361-4019

ALTURDYNE ENERGY SYSTEMS: 26, 47, 75, 94, 114, 141, 186, 231, 284tons;
Reciprocating compressors, industrial grade engines, analogue controls
Associated Air Systems, Inc.: Al Schnur, 404-587-0970

CUSTOM BUILT:
Owsley Brothers: Bob Reid, 404-361-1100
650ton; Waukesha engine; York centrifugal compressor;
Heat recovery available

Utility Systems Corp.: Richard Nelson, 516-287-3741
250, 400, 550, 665, 800ton; Caterpillar engines, York screw comp.
Heat recovery available

DIRECT FIRED 2-STAGE ABSORPTION: *No CFC's !*

CARRIER: 100 - 500tons; operates w/59F condenser water
Carrier: Shawn Wood, 404-988-0893

McQuay-Sanyo: 20 - 1,500tons; simultaneous heating/cooling optional
Brake & Hegyan (Atlanta): Michael Lawler, 404-455-1954

TRANE: 100,120,150,180,200,240,300,350,400,450,500, up to 1100tons
Units 550tons and smaller can be built for outside installation
Trane: Jim Gieselman, 404-321-7500

YORK: 100,125,140,150,170,200,250,270,320,345,400,430,500 up to 1,500tons
Manufactured by Hitachi; will manufacture in USA
York Int'l.: Clint Knudson, 404-925-1002

YAZAKI: 20,30,40,50,60,80,100tons
Atlanta Gas Light Co.: Jim Sullivan, 404-584-3758

STEAM FIRED ABSORPTION: *No CFC's !*
Two Stage:

CARRIER: 150,250,400,500,600,700,800,1000,1200,1500tons

TRANE: 385-1060tons
Input of 12.2lbs/ton-hr, 123psig steam for rated full load

YORK: 250,270,310,360,400,450,500, up to 1,500tons
Input of 9.9lbs/ton-hr, 114psig steam for rated full load

MCQUAY-SANYO: 100-1500tons

Single Stage:
CARRIER: 70-815tons
Input of 18lbs/ton-hr, 14psig steam for rated full load

TRANE: 101-1,660tons
Input of 18.7lbs/ton-hr, 14psig steam for rated full load

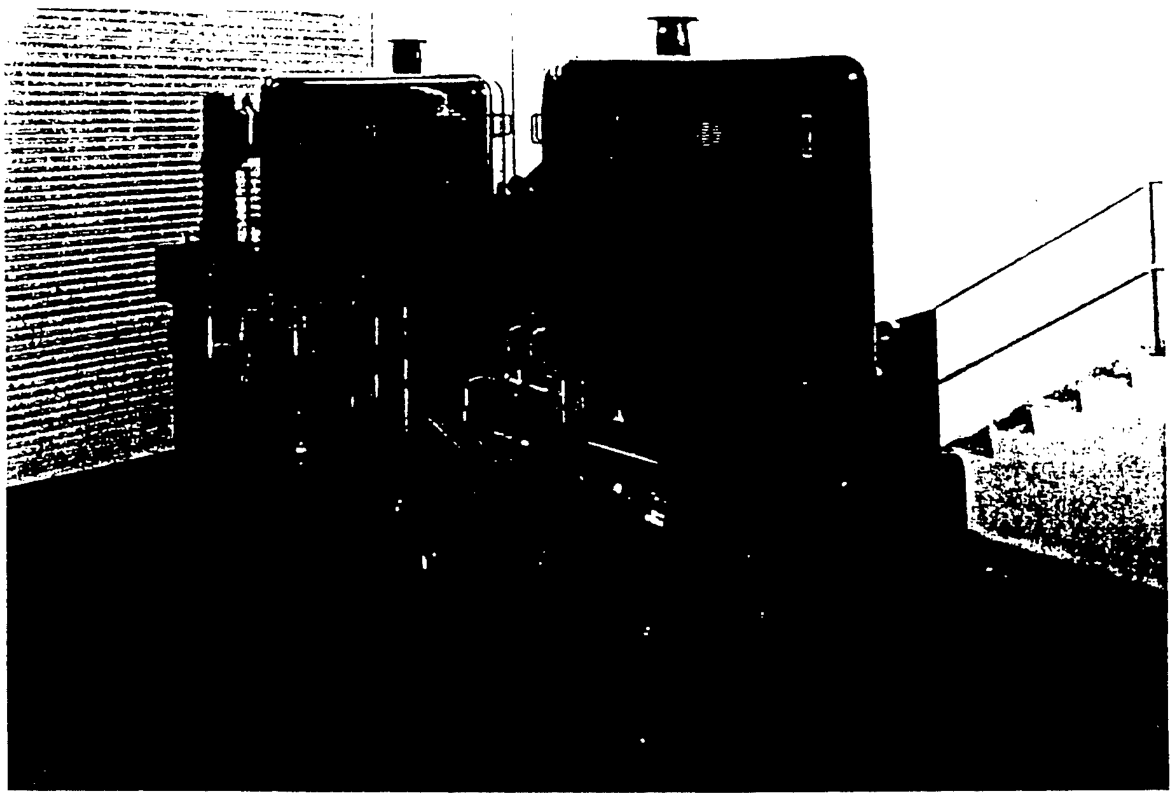
YORK: 120 to 1,400tons
Input of 18.3lbs/ton-hr, 15psig steam for rated full load

HEAT RECOVERY ABSORPTION: *No CFC's !*

YORK: 100,125,140,150,170,200,250,320,345,400,450,500, up to 1,500tons
Uses clean exhaust gas 550-1500F
Option to use engine jacket water heat recovery

TECOCHILL

Gas Engine Driven Chiller Systems



Centrifugal Compressor Line

- **30 to 95% Energy Savings**
- **Fully Automatic Unattended Operation**
- **Continuous 20 to 100% Modulation**
- **Open Drive Compressor**
- **Hot Water Available**
- **Remote Diagnostics**
- **Made in U.S.A.**

TECOCHILL centrifugal chillers provide cost effective and reliable chilled water for commercial, industrial and institutional cooling needs. The chillers combine the familiarity of vapor compression refrigeration with the energy efficiency of TecoDrive, a natural gas prime mover. TECOCHILL chillers provide substantial savings over electric and absorption chillers by reducing energy costs 30 to 95%. These savings are due to an exceptionally efficient design, lower utility costs and avoided electric demand charges.

The TECOCHILL CH-500 chiller uses two TecoDrive engines directly coupled to open-drive centrifugal compressors. The TECOCHILL CH-250 chiller uses a single TecoDrive engine. TecoDrive engines have earned a strong reputation for reliability and performance in the HVAC community. This reputation has resulted from millions of hours of operation in chillers and cogeneration modules.

TECOCHILL chillers provide the highest coefficient of performance (COP) of any type of gas chiller. The inherent variable speed capability of the TecoDrive engine and compressor team offers even higher part-load system efficiencies and superior load following capability. Continuous modulation from 20 to 100% provides customers with precisely controlled chilled water temperature.

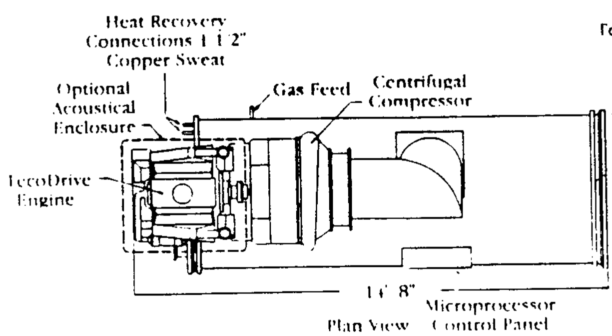
A powerful microprocessor based control system provides fully automatic operation, continuous chiller monitoring, digital display, fault and safety diagnostics and convenient interface to energy management systems in a user-friendly package. These features have resulted in a significant reduction in service costs.

Optional equipment includes a heat recovery package that yields as much as 1,700,000 Btu/hr of hot water which can supplement boilers or other thermal needs. Acoustical enclosures are available that reduce noise level. A remote monitoring and control system is available that permits remote operation and diagnostics via telephone and personal computer.

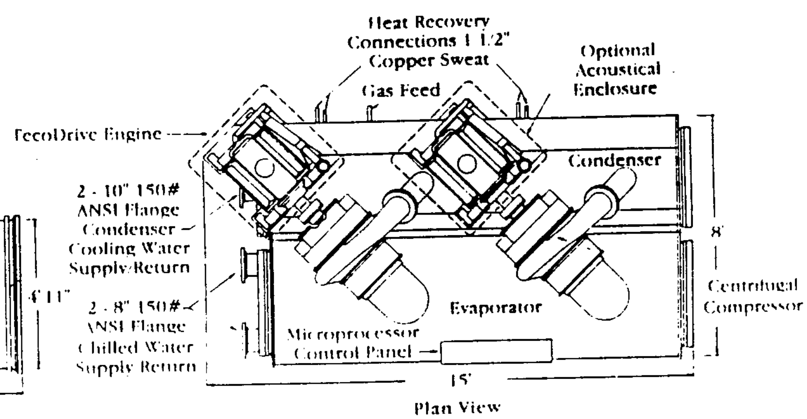
Made in the USA, TECOCHILL chillers are readily available and serviced by factory-trained local HVAC service professionals. TECOCHILL chillers are equal in size to electric chillers and smaller than absorption chillers. Also, open-drive compressors allow easier conversion to alternate refrigerants in the future. The chiller has been designed for ease of installation and with standard connections.

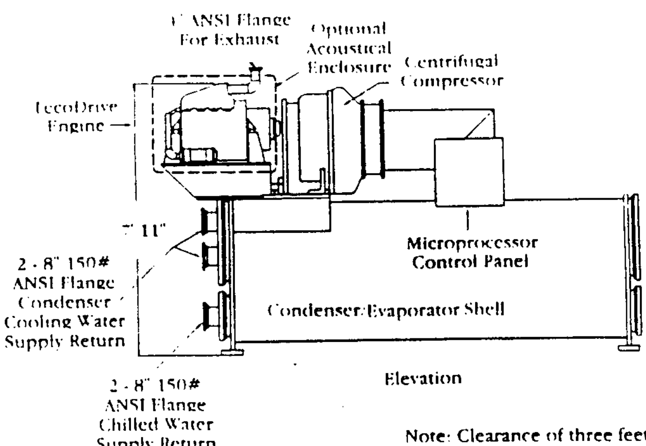
A cooling system evaluation is no longer complete without a TECOCHILL comparison. For further information, please contact Tecogen Inc. directly or our local sales representative.

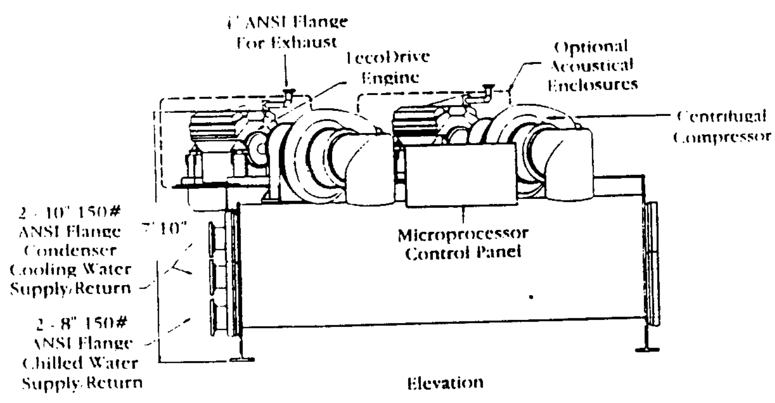
TECOCHILL CH-250



TECOCHILL CH-500





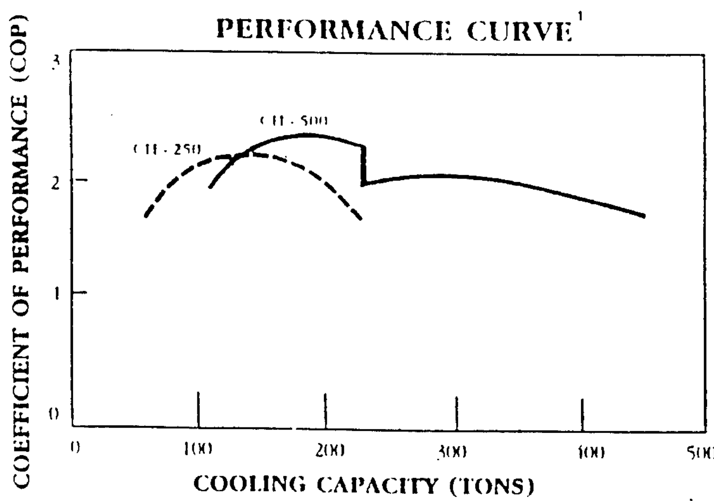


Note: Clearance of three feet required on all sides. Scale: 3/16" = 1 ft.
All specifications and materials subject to change without notice.
All specifications and ratings are +5%

GENERAL SPECIFICATIONS

Model	CH - 250	CH - 500
Capacity (Tons)[1]	~~230~~ 220	~~460~~ 430
COP		
Full load	1.7	1.7
Integrated Part Load Value (IPLV)	2.0	2.0
RPM Full Load	3000	3000
Gas Input (SCFH)[2] @6 - 28 in. H_2O	1750	3500
Recoverable Heat at Full Load (BTU/H)[3]	850,000	1,700,000
Acoustic Level (dBA) @ 20 ft.with Optional Enclosure	82	85
Electric Power Requirements	208 VAC Three phase, 35 Amps Service, 4 kW	208 VAC Three phase, 50 Amps Service, 7 kW
Chilled Water Flow(GPM)	600	1200
Cooling Tower Requirements		
Condenser Flow Rate (GPM)	750	1500
Pressure Drop (ft. H_2O)	11	11
Temperatures, without Exhaust Heat Exchangers (°F)[3]	85.0 - 95.0	85.0 - 95.0
Temperatures, with Exhaust Heat Exchangers (°F)[3]	85.0 - 96.3	85.0 - 96.3
Exhaust		
Without Exhaust Heat Exchangers[3]	4 in. ANSI Flange, 300 SCFM, 26 in. of water max. back pressure, 1200°F max. temperature	(Same per engine)
With Exhaust Heat Exchangers[3]	4 in. ANSI Flange, 300 SCFM, 16 in. of water max. back pressure, 300°F max. temperature	(Same per engine)
Refrigerant	R-11(1,010 lbs.)	R-11 (1,770lbs)
TecoDrive™ Engines	One	Two
Rigging Weight (lbs.)	18,000	26,000
Dimensions	14'8"long x 4'11" wide x 7'11" high	15' long x 8' wide x 7'10" high

Note 1 Per ARI 550 - 88 Method
Note 2 HHV 1020 BTU/SCF
Note 3 60% of heat from engine jacket, exhaust manifold and oil cooler, 40% from engine exhaust heat exchanger



All specifications and materials subject to change without notice.
All specifications and ratings are +5%

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #310
DATE: 02-Sep-92
FILE: DEMAND.WK
PREPARED BY:
CHECKED BY:

ECO: 16, INVESTIGATE POST DEMAND

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

FT. MC PHERSON TRANE HEAT PUMP SCHEDULE
ENERGY SAVINGS OPPORTUNITY SURVEY – FT. MC PHERSON, GA

BLDG NO.	QTY.	MODEL NO. BWD___100_0	DESCRIPTION	VOLTS EACH	AMPS EACH	TOTAL KW	TONS EACH
1	2	724AB	SPLIT HP	208	30	11	2
1	2	730AB	SPLIT HP	208	40	15	2.5
2	2	724AB	SPLIT HP	208	30	11	2
2	2	730AB	SPLIT HP	208	40	15	2.5
3	2	724AB	SPLIT HP	208	30	11	2
3	2	730AB	SPLIT HP	208	40	15	2.5
4	2	724AB	SPLIT HP	208	30	11	2
4	2	730AB	SPLIT HP	208	40	15	2.5
5	2	742AB	SPLIT HP	208	50	19	3.5
6	2	724AB	SPLIT HP	208	30	11	2
6	2	718AB	SPLIT HP	208	20	7	1.5
7	2	724AB	SPLIT HP	208	30	11	2
7	2	718AB	SPLIT HP	208	20	7	1.5
8	2	724AB	SPLIT HP	208	30	11	2
8	2	718AB	SPLIT HP	208	20	7	1.5
9	2	724AB	SPLIT HP	208	30	11	2
9	2	718AB	SPLIT HP	208	20	7	1.5
10	1	760AA	SPLIT HP	230	60	12	5
10	1	748AA	SPLIT HP	230	50	10	4
11	4	730AB	SPLIT HP	208	40	30	2.5
12	4	730AB	SPLIT HP	208	40	30	2.5
13	4	730AB	SPLIT HP	208	40	30	2.5
14	4	730AB	SPLIT HP	208	40	30	2.5
15	2	730AB	SPLIT HP	208	40	15	2.5
15	2	724AB	SPLIT HP	208	30	11	2
17	4	730AB	SPLIT HP	208	40	30	2.5
18	1	BWX736B100A0	SPLIT HP	230	30	6	3
18	1	724AB	SPLIT HP	208	30	6	2
19	4	730AB	SPLIT HP	208	40	30	2.5
20	1	BWX736B100A0	SPLIT HP	230	30	6	3
20	1	742BA	SPLIT HP	208	50	9	3.5
136	1	BWX736B100A0	SPLIT HP	230	30	6	3
137	1	730AB	SPLIT HP	208	40	7	2.5
138	1	730AB	SPLIT HP	208	40	7	2.5

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
EMC PROJECT: #310
DATE: 02-Sep-92
FILE: DEMAND.WK
PREPARED BY:
CHECKED BY:

ECO: 16, INVESTIGATE POST DEMAND

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

FT. MC PHERSON TRANE HEAT PUMP SCHEDULE
ENERGY SAVINGS OPPORTUNITY SURVEY - FT. MC PHERSON, GA

BLDG NO.	QTY.	MODEL NO. BWD___100_0	DESCRIPTION	VOLTS EACH	AMPS EACH	TOTAL KW	TONS EACH
139	1	730AB	SPLIT HP	208	40	7	2.5
140	1	730AB	SPLIT HP	208	40	7	2.5
141	1	730AB	SPLIT HP	208	40	7	2.5
142	1	730AB	SPLIT HP	208	40	7	2.5
409	8	724AB	SPLIT HP	208	30	45	2
410	8	724AB	SPLIT HP	208	30	45	2
506	2	730AB	SPLIT HP	208	40	15	2.5
507	2	730AB	SPLIT HP	208	40	15	2.5
508	2	730AB	SPLIT HP	208	40	15	2.5
509	2	730AB	SPLIT HP	208	40	15	2.5
510	2	730AB	SPLIT HP	208	40	15	2.5
515	2	730AB	SPLIT HP	208	40	15	2.5
523	2	730AB	SPLIT HP	208	40	15	2.5
524	2	730AB	SPLIT HP	208	40	15	2.5
526	2	730AB	SPLIT HP	208	40	15	2.5
527	2	730AB	SPLIT HP	208	40	15	2.5
528	2	730AB	SPLIT HP	208	40	15	2.5
532	1	BWX736B100A0	SPLIT HP	230	30	6	3
533	2	730AB	SPLIT HP	208	40	15	2.5
534	2	730AB	SPLIT HP	208	40	15	2.5
535	2	730AB	SPLIT HP	208	40	15	2.5
536	2	730AB	SPLIT HP	208	40	15	2.5
537	2	730AB	SPLIT HP	208	40	15	2.5
538	2	730AB	SPLIT HP	208	40	15	2.5
601	2	730AB	SPLIT HP	208	40	15	2.5
602	2	730AB	SPLIT HP	208	40	15	2.5
603	2	730AB	SPLIT HP	208	40	15	2.5
604	2	730AB	SPLIT HP	208	40	15	2.5
605	2	730AB	SPLIT HP	208	40	15	2.5
TOTAL	108					931	

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO: 16 – FM RADIO CONTROL SYSTEM

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 02-Sep-92
FILE: ECO-16.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	14.45 UPWG
Electric Savings	$0.0255 / kWh	11.11 UPWE
Demand Savings	$8.85 / kW	10.59 UPW

Economic Life: 15 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON-ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
	214	0	0	0	$0	$21,983	$0	$21,983	$81,982	2.8	3.7

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

[X] CODE A [ ] CODE B [ ] CODE C [ ] OTHER

EFFECTIVE PRICING DATE APR 92

DATE PREPARED 22-Apr-92

DRAWING NO.

SHT OF

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

ESTIMATOR RMG

CHECKED BY CEL

NATURAL GAS ENGINE DRIVEN CHILLER	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
ENGINE DRIVEN CHILLER (460 TONS)	1	EA	56	56	$20.88	$1,169.28			$275,000.00	$275,000.00	$276,169.28		
MISC. PIPE CONNECTIONS	1	LS							$1,500.00	$1,500.00	$1,500.00		
REMOVE EXISTING CHILLER	1	EA	36	36	$20.88	$751.68					$751.68		
SUBTOTAL						$1,920.96				$276,500.00	$278,420.96		
OVERHEAD, BOND	15%					$288.14				$41,475.00	$41,763.14		
PROFIT	10%					$192.10				$27,650.00	$27,842.10		
COST SUB-TOTAL						$2,401.20				$345,625.00	$348,026.20		
CONTINGENCY	15%					$360.18				$51,843.75	$52,203.93		
TOTAL						$2,761.38				$397,468.75	$400,230.13		

DA FORM 5418-R, APR 85

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study LOCATION Ft. McPherson & Ft Gillem	INVITATION NO./CONTRACT NO. DACA 21-91-C-0097 [X] CODE A [ ] CODE B [ ] CODE C [ ] OTHER ______	EFFECTIVE PRICING DATE APR 92 DRAWING NO. ESTIMATOR RMG	DATE PREPARED 22-Apr-92 SHT OF CHECKED BY CEL

PEAK SHAVING GENERATOR	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
500 KW GENERATOR	1	EA	66	66	$21.17	$1,397.22			$72,500.00	$72,500.00	$73,897.22		
ELEC. FEEDER (1000 AMPS)	50	FT			$21.17	$2,950.00				$3,650.00	$6,600.00		
TANK	1	EA	40	40	$20.88	$835.20			$6,900.00	$6,900.00	$7,735.20		
PAD	1	EA	40	40	$20.88	$835.20			$1,500.00	$1,500.00	$2,335.20		
SUBTOTAL						$6,017.62				$84,550.00	$90,567.62		
OVERHEAD, BOND	15%					$902.64				$12,682.50	$13,585.14		
PROFIT	10%					$601.76				$8,455.00	$9,056.76		
COST SUB-TOTAL						$7,522.03				$105,687.50	$113,209.53		
CONTINGENCY	15%					$1,128.30				$15,853.13	$16,981.43		
TOTAL						$8,650.33				$121,540.63	$130,190.95		

DA FORM 5418-R, APR 85

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO.	DACA 21-91-C-0097
[X] CODE A [ ] CODE B [ ] CODE C [ ] OTHER	
EFFECTIVE PRICING DATE	APR 92
DATE PREPARED	23-Apr-92
PROJECT	Ft. McPherson & Ft. Gillem ESOS Study
LOCATION	Ft. McPherson & Ft Gillem
DRAWING NO.	
SHT OF	
ESTIMATOR	RMG
CHECKED BY	CEL

FM RADIO CONTROL UCS	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
BASE COMPUTER w/ SOFTWARE	1	EA	8	8	$21.17	$169.36			$25,000.00	$25,000.00	$25,169.36		
TRANSMITTER, ANTENNA	1	EA	16	16	$21.17	$2,950.00			$12,000.00	$3,650.00	$6,600.00		
PROGRAMMING	25	EA				$150.00					$150.00		
TRAINING, START-UP	1	LS				$5,000.00					$5,000.00		
RADIO SWITCHES	108	EA	1.5	162	$21.17	$3,429.54			$100.00	$10,800.00	$14,229.54		
SUBTOTAL						$11,698.90				$39,450.00	$51,148.90		
OVERHEAD, BOND	15%					$1,754.84				$5,917.50	$7,672.34		
PROFIT	10%					$1,169.89				$3,945.00	$5,114.89		
COST SUB-TOTAL						$14,623.63				$49,312.50	$63,936.13		
CONTINGENCY	15%					$2,193.54				$7,396.88	$9,590.42		
TOTAL						$16,817.17				$56,709.38	$73,526.54		

DA FORM 5418-R, APR 85

E M C ENGINEERS, INC.	JOB Fort McPherson/Fort Gillem ESOS Study
Denver • Colorado Springs • Atlanta • Germany	SHEET NO EMC #3105-000 OF
	CALCULATED BY CEL DATE
	CHECKED BY DATE
	SCALE

1) RADIO CONTROL FAMILY HOUSING AC UNITS

-108 AC units
-931 KW load
-Estimate off for 7 minutes every 30 minutes, (7/30) = .23 load shed.
-931 KW * .23 = 214 KW
-Cost $73,527
-Cost per KW, $73,527/214KW = $344

2) THERMAL STORAGE, BLDG. 200

-750 ton load, est 487 KW
-With pumps, tower, etc. 673 KW
-Cost $1,044,893
-Cost per KW, $1,044,893/673 = $155

3) GAS DRIVEN CHILLER

-460 ton load, est 300 KW
-Cost $400,230
-Cost per KW, $400,230/300 = $134

4) LIGHTING CONTROL

-Control 310 watts of light
(2, 4'x 2', 4 tube fluorescent)
-1 wall switch, $65.11
-Cost per KW, $65.11/.31 = $210

E M C ENGINEERS, INC.	JOB Fort McPherson/Fort Gillem ESOS Study
Denver • Colorado Springs • Atlanta • Germany	SHEET NO EMC #3105-000 OF
	CALCULATED BY CEL DATE
	CHECKED BY DATE
	SCALE

5) PEAK SHAVING GENERATOR

-500 KW generator
-Est. cost $130,190
-Cost per KW, $130,190/500 = $260

6) HIGH EFFICIENCY MOTOR

-5 hp high efficiency replacement
-.81 KW savings
-Cost $488
-Cost per KW, $488/.81 = $602

7) EXIT SIGN REPLACEMENT

-Replace bulbs in 10 fixtures
-.3 KW saved
-$380 construction cost
-Cost per KW, 380/.3 = $1267

APPENDIX C-17

EVALUATE BOILER OPERATION

(This ECO was not applicable to Ft. McPherson)

APPENDIX C-18

EXIT SIGN RETROFIT

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

STUDY: MECO25
LCCID 1.062

INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-18 EXIT SIGN RETROFIT
ANALYSIS DATE: 07-09-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT		
A. CONSTRUCTION COST	$	14858.
B. SIOH	$	818.
C. DESIGN COST	$	892.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	16568.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	351.	$ 2620.	15.61	40902.
B. DIST	$ .00	0.	$ 0.	21.66	0.
C. RESID	$ .00	0.	$ 0.	26.51	0.
D. NAT G	$ 4.67	0.	$ 0.	23.77	0.
E. COAL	$ .00	0.	$ 0.	16.06	0.
F. TOTAL		351.	$ 2620.		$ 40902.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 23.
(1) DISCOUNT FACTOR (TABLE A) 14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 334.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 334.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 13498.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 2643.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 41236.

6. DISCOUNTED SAVINGS RATIO (SIR)≐(5 / 1E)= 2.49
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 6.27

REPLACE EXIT SIGN BULBS SAMPLE CALCULATION, ECO #18
BUILDING 41

Given:

# of Exit Signs	= 4 signs	- from field survey
Existing Bulb Wattage	= 40 Watts	- from field survey
Improved Bulb Wattage	= 10 Watts	- from manufacturer's data
Gas Cost	= $4.67 / MBtu	- from utility rate analysis
Electric Cost	= $0.0255 / kWh	- from utility rate analysis
Demand Cost	= $8.85 / kW	- from utility rate analysis

Existing Energy Usage:

(4 signs)*(40 Watts / sign) = 160 Watts
(0.16 kW)*(8,760 hrs / yr) = 1,402 kWh

Improved Energy Usage:

(4 signs)*(10 Watts / sign) = 40 Watts
(0.04 kW)*(8,760 hrs / yr) = 350 kWh

Peak Demand Savings:

(0.16 - 0.04 kW) = 0.12 kW

Annual Energy Savings:

- Electric:	(1,402 - 350 kWh)	= 1,052 kW
- Gas:		= 0 MBtu

Annual Energy Cost Savings:

(0 MBtu)*($4.67 / MBtu) + (1,052 kWh)*($0.0255 / kWh) + (0.12 kW)*($8.85 / kW)*(4 + .95 * 8) = $39 / yr

Annual Increased recuring cost

($7.95) - (2 * $2.25) * (8,769 yr / 10,000 hr) = $3.02 / yr / fixture
4 fixtures = 4 * $3.02 = $12.08 / yr

Estimated Construction Cost:

$38.00 / sign - from engineer's cost estimate

($38.00 / sign)*(4 sign) = $152

$152 + ($152 * .055 SIOH) + ($152 * .06 DESIGN) = $169

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: REPLACE EXIT SIGN LIGHTING WITH FLUORESCENT LIGHT RETROFIT KIT

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 07/17/92
FILE: EXITLITE.WK3
PRPARED BY: CAMERAN DIBAI
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
INCREMENTAL GAS COST	$4.67 MBtu	23.77 UPWG
INCREMENTAL ELECTRIC COST	$0.0256 kWh	15.61 UPWE
ELECTRIC DEMAND CHARGE	$102.66 kW	14.53 UPW
ECONOMIC LIFE	25 YRS	
ESTIMATED 8760 HOURS OF EXIT LIGHTING PER YEAR		

BLDG	NUMBER OF FIXTURES	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWH)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND SAVINGS ($)	ANNUAL NON-ENERGY SAVINGS ($)	TOTAL ANNUAL SAVINGS ($)	CONST. COST ($)	SIR	SIMPLE PAYBACK (YRS)
41	4	0.12	1,051	0	4	$27	$12	($12.08)	$27	169	2.5	6.2
56	12	0.36	3,154	0	11	$81	$37	($36.24)	$81	508	2.5	6.2
58	12	0.36	3,154	0	11	$81	$37	($36.24)	$81	508	2.5	6.2
60	17	0.51	4,468	0	15	$114	$52	($51.34)	$115	720	2.5	6.2
62	12	0.36	3,154	0	11	$81	$37	($36.24)	$81	508	2.5	6.2
101	12	0.36	3,154	0	11	$81	$37	($36.24)	$81	508	2.5	6.2
170	20	0.6	5,256	0	18	$135	$62	($60.40)	$136	847	2.5	6.2
171	22	0.66	5,782	0	20	$148	$68	($66.44)	$149	932	2.5	6.2
181	30	0.9	7,884	0	27	$202	$92	($90.60)	$204	1271	2.5	6.2
184	24	0.72	6,307	0	22	$161	$74	($72.48)	$163	1017	2.5	6.2
200	100	3	26,280	0	90	$673	$308	($302.00)	$679	4237	2.5	6.2
246	21	0.63	5,519	0	19	$141	$65	($63.42)	$143	890	2.5	6.2
363	85	2.55	22,338	0	76	$572	$262	($256.70)	$577	3601	2.5	6.2
366	2	0.06	526	0	2	$13	$6	($6.04)	$14	85	2.5	6.2
400	10	0.3	2,628	0	9	$67	$31	($30.20)	$68	424	2.5	6.2
401	8	0.24	2,102	0	7	$54	$25	($24.16)	$54	339	2.5	6.2
TOTAL	391	11.73	102,755	0	350.701	2630.52	1204.2	-1180.82	2653.9	16567	2.5	6.2

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

X CODE A ☐ CODE B ☐ CODE C ☐ OTHER

EFFECTIVE PRICING DATE APR 92

DRAWING NO.

ESTIMATOR RMG

DATE PREPARED 22-Apr-92

SHT OF

CHECKED BY CEL

	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
EXIT SIGN RETROFIT KIT	1	EA	1	0.5	$21.17	$10.59			$15.00	$15.00	$25.59		
SUBTOTAL						$10.59				$15.00	$25.59		
OVERHEAD, BOND	15%					$1.59				$2.25	$3.84		
PROFIT	10%					$1.06				$1.50	$2.56		
COST SUB-TOTAL						$13.23				$18.75	$31.98		
CONTINGENCY	15%					$1.98				$2.81	$4.80		
TOTAL						$15.22				$21.56	$36.78		

DA FORM 5418-R, APR 85

APPENDIX C-19

LIGHTING UPGRADES

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: MECO25
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-19 LIGHT RETROFIT
ANALYSIS DATE: 07-09-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	644577.
B. SIOH	$	35452.
C. DESIGN COST	$	38675.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	718704.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	5008.	$ 37413.	15.61	584017.
B. DIST	$ .00	0.	$ 0.	21.66	0.
C. RESID	$ .00	0.	$ 0.	26.51	0.
D. NAT G	$ 4.67	0.	$ 0.	23.77	0.
E. COAL	$ .00	0.	$ 0.	16.06	0.
F. TOTAL		5008.	$ 37413.		$ 584017.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 64368.
(1) DISCOUNT FACTOR (TABLE A) 14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 935267.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 935267.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 192726.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) 1.08
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 101781.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 1519285.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 2.11
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 7.06

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 19 – PNL Lights

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 14-Jul-92
FILE: ECO-19.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	23.77 UPWG
Electric Savings	$0.0255 / kWh	15.61 UPWE
Demand Savings	$8.85 / kW	14.53 UPW

Economic Life: 15 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON-ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
CCF	331	774,540	0	2,641	$19,751	$33,980	$0	$53,731	$297,132	2.7	5.5
Office	296	692,640	0	2,362	$17,662	$30,387	$0	$48,050	$421,571	1.7	8.8
TOTAL	627	1,467,180	0	5,003	$37,413	$64,368	$0	$101,781	$718,703	2.1	7.1

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 19 – PNL Lights

CLIENT CONTRACT NO: DACA21–91–C–0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 21–APR–92
FILE: ECO–19.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

Operation: 2340 hrs / yr

BLDG TYPE	EXIST DEMAND (kW)	IMPRVD DEMAND (kW)	COOLING DEMAND SAVINGS (kW)	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	TOTAL CONST COST ($)
CCF	507	255	79	331	774,540	$266,486
Office	710	414	0	296	692,640	$378,090

TRI-SERVICE MILITARY CONSTRUCTION PROGRAM (MCP) INDEX

CALENDAR YEAR	*1990	*1991	1992	1993	1994	1995	1996
JANUARY	1676	1742	1810	1875	1938	1999	
FEBRUARY	1679	1746	1813	1878	1941	2002	
MARCH	1682	1750	1816	1881	1944	2005	
APRIL	1686	1753	1819	1885	1947	2009	
MAY	1693	1760	1826	1891	1953	2015	
JUNE	1700	1767	1833	1897	1959	2021	
JULY	1706	1773	1839	1904	1966	2027	
AUGUST	1713	1780	1846	1910	1972	2033	
SEPTEMBER	1720	1787	1853	1916	1978	2039	
OCTOBER	1726	1793	1859	1922	1984	2045	
NOVEMBER	1731	1799	1864	1927	1981		
DECEMBER	1736	1805	1869	1932	1990		

Example: (For 10 Month Construction Period)

Submittal Date	- 1 Sept 90	1720	-- 13 Months
Bid Opening Date	- 1 Apr 91		
Contract Award Date	- 1 May 91		
Midpoint of Construction	- 1 Oct 91	1793	

Cost Growth Factor = 1793 / 1720 = 1.0424 Use 1.04

Use 4 % Per Fiscal Year For Projection Beyond FY 1997

* Historical

Cost Escalation

MCP Index

Report Date: 12/89 (use 1/90) 1676

Present Date 4/92 1819

Cost Growth Factor = 1819/1676 = 1.0853 use $\boxed{1.09}$

FEASIBILITY STUDY FOR
LIGHTING SHARED ENERGY SAVINGS PROJECT
FORT McPHERSON AND FORT GILLEM, GEORGIA

U.S. Army Corps of Engineers
Huntsville Division
Contract DACA87-89-D-0007
Delivery Order 0005

FINAL REPORT

July 20, 1990

The fixtures in the Generals' offices, Rooms 333, 336, and 339, should be changed to a 2 x 4 or a 2 x 2 louvered fixture the same style as Item 1. By installing fixtures as specified in Item 1, a maintained foot candle level of 60 FC will result, yielding a 78 percent reduction in wattage in comparison to the existing incandescent system estimated wattage of 7 kW. Installation costs are estimated at $1,608. The fixtures can be connected to two fluorescent dimming circuits to provide full control of the lighting level. Simple payback based on energy savings will be 3 years. Increased maintenance savings not included will shorten payback period.

The basement level or any areas without any artificial lighting could have a minimum number of fixtures powered by a battery system or by the building UPS system to provide continuous lighting during generator startup, (limited to 10 seconds by life safety codes), thus eliminating the interruption of critical operations due to a utility failure.

Exit signs with incandescent lamps should be replaced or retrofitted with fluorescent lamps which will give a lighting wattage reduction of 80 percent from an estimated load of 3 kW, and an increase in light output of over 65 percent. The installation cost is estimated at $2,220. The use of a Liquid Crystal Display (LCD) type is not recommended since LCD signs do not provide sufficient illumination to be visible during a fire emergency evacuation. Simple payback based on energy savings will be 1.5 years. Increased maintenance savings not included will shorten payback period.

3.7 CAPITAL COST ESTIMATE

3.7.1 Warehouse

The 11,100 existing fluorescent fixtures in use will be replaced with 4,964 High Pressure Sodium (HPS) fixtures at a cost of $1,255,900 (in 12/89 dollars). This does not include $273,000 for rewiring from 120 V to 277 V believed necessary for the warehouses because of the age and condition of the existing 120 V wiring. Because this rewiring should be done by the government anyway, we have assumed that it would be done by separate contract and should not be reflected in the SES analysis of potential costs and

benefits. Including the cost of rewiring will make it harder for the Third Party Contractor to meet his economic goals with the Shared Energy Savings Contract. However, the effect of rewiring on the gross payback will be included in Section 5. The unit cost of installing new HPS fixtures is $253/fixture. This includes the cost of the luminaire and lamp, and the cost of labor at $25/hr. The equipment cost is based on discussions with potential vendors.

The cost estimate is based on replacing the fixtures at Fort Gillem. Fort McPherson warehouses, although likely to be included in any retrofit program, contain only 5 percent of the total number of fixtures and was not included in the evaluation.

3.7.2 Office

The existing fluorescent fixtures will be replaced with parabolic louvered fixtures with energy-saving lamps and ballast arrangements. The cost will be $1,294,120 for both Fort Gillem ($702,765) and Fort McPherson ($591,355 including $244,483 for CCF), including the Comand and Control Facility. Unlike the warehouses, no supply rewiring is required.

3.8 MAINTENANCE COST ESTIMATE

3.8.1 Warehouse

The cost of yearly maintenance for HPS fixtures is based on group relamping at 75 percent of the lamp life. The procedure is similar to that described in Section 3.4. Maintenance includes the material and labor necessary to replace and clean lamps and to replace ballasts. Material costs are based on discussions with vendors. The average annual cost of maintaining the fixtures is $53,611.

SECTION 4

ENERGY COMPARISON

The lighting retrofit programs described in Section 3.5 for offices and warehouses offer significant energy savings. In the offices, switching to parabolic louvered fixtures and energy saving magnetic ballasts will result in the following:

	Fort Gillem	Fort McPherson	Total
Existing load (kW)	1,201	1,217	2,418
Future loads (kW)	718	669	1,387
Savings (kW)	483	548	1,031
Percent savings			43%

In the CCF alone, the load will be reduced from 507 kW to 255 kW, a reduction of 50 percent.

In Fort Gillem's warehouses, switching to High Pressure Sodium fixtures will reduce the lighting load from 1,705 kW to 918 kW, a reduction of 787 kW or 46 percent.

The savings are based on the energy reduction calculated by system characteristics (connected load and hours of operation) observed in the walkdown, compared to reduction in power of the recommended system.

The power cost savings will not be quite so high in percentage savings because of Georgia Power Company's declining block rate structure. The rates are as follows:

	Incremental Usage (kWh)	Rate ($/kWh)
≤300 hr/mo * Billing Demand:	50,000	0.05710
(up to maximum of	150,000	0.05590
1,961,500 kWh)	800,000	0.04150
	961,400	0.03950
≥300 hr/mo * Billing Demand:	Balance of kWh	0.01110

In addition, a fuel charge of $0.016045 is charged for every kWh of usage.

The lighting systems are assumed to be in use 9 hours/day, 5 days/week or an average of 195 hours/month.

Table 4-1 presents the existing and future power charges for all of the offices including the Command and Control Facility and for the CCF separately. Note that the average rate increases with the modification because a greater percentage of the power usage is shifted to the higher rates. The total bill for all office lighting, however, is reduced by 45 percent and for the CCF alone, by 50 percent. In addition to the power savings due to lighting system changes in the CCF, there will be a net decrease in power consumed for air conditioning. The CCF is cooled by a motor-driven chiller. The differential energy consumption was determined by modeling the building and HVAC system both before and after the proposed modification. The total annual energy reduction, including the effects on heating, is 184,552 kWh/yr. The HVAC load reduction of other buildings was not calculated because due to system sizes and usage patterns the energy reduction will be small compared to lighting energy reduction.

The energy cost savings may be overstated due to electric loads other than lighting. These additional loads will generally be unaffected by the proposed lighting system changes and therefore, reductions in lighting system loads may occur in lower rate blocks. The approach used is more optimistic for the value of savings.

The warehouse power charges are presented on Table 4-2. The average rate will increase from $0.066/kWh to $0.072 kWh, but the total bill will be reduced by 41 percent.

TABLE 4-1

OFFICE (ALL) POWER COST

Monthly Energy Rate which Includes Demand			Existing System Avg. 471,534 kWh/Mo		Modified System Avg. 270,314 kWh/Mo	
Hr/Mo	Incr. kWh	Rate	kWh	Cost	kWh	Cost
<300	50,000	$0.0571	50,000	$ 2,855	50,000	$ 2,855
	150,000	0.0559	150,000	8,385	150,000	8,385
	800,000	0.0415	271,534	11,269	70,314	2,918
	961,000	0.0395	0	0	0	0
>300	(Balance)	0.0111	0	0	0	0
Fuel	All kWh	0.016045	471,534	7,566	270,314	$ 4,337
				$30,074		$18,495
			Avg. Rate	$0.064/kWh		$0.068/kWh

COMMAND AND CONTROL FACILITY POWER COST

	Existing System			Modified System		
	kWh	@ Avg. rate from above	Cost	kWh	@ Avg. rate from above	Cost
Lighting Costs:	98,865	$0.064/kWh	$6,327	49,725	$0.068/kWh	$3,381
Differential Air Cond. Costs:	Base		base	-15,379	0.068	-1,046
			$6,327			$2,335

A/C Demand Savings = 15,379 kWh /(195 hrs/mo) = $\boxed{79}$ kW

APPENDIX C-20

COMPUTER SIMULATION SUMMARIES

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: Computer Simulation Summary

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 10-APR-92
FILE: M027ECO.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

Bldg: M027 **Area: 8,280 ft^2**

Run Description	Heating Gas Use (kBtu/yr)	Heating Electric Use (kWh/yr)	Cooling Electric Use (kWh/yr)	Fan Electric Use (kWh/yr)	Pump Electric Use (kWh/yr)	Lighting Electric Use (kWh/yr)	Recept. Electric Use (kWh/yr)	Total Electric Use (kWh/yr)	Peak Electric Demand (kW)	Total Gas Use (MBtu/yr)	Total Energy Use (MBtu/yr)
Baseline	38,225	793	14,952	27,682	4,544	12,510	12,421	72,902	26	38	287
ECO#2	51,128	933	15,590	27,682	4,544	12,510	12,421	73,679	27	51	303
Savings/(Loss)	(12,903)	(140)	(637)	0	0	0	0	(777)	(1)	(13)	(16)
ECO#3	37,667	792	14,951	27,682	4,544	12,510	12,421	72,900	26	38	286
Savings/(Loss)	557	1	2	0	0	0	0	2	0	1	1

Building	ECO
027	2

This building currently has adequate roof and wall insulation, double-pane window, and acceptable infiltration levels. For purposes of doing take-offs for other buildings, this building was simulated with reduced roof and wall insulation, single-pane windows, and increased infiltration. The results from the new computer simulations were then compared with those from baseline simulation. These differences were then used to calculate the energy factors that were used on the take-off buildings.

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: Computer Simulation Summary

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 10-APR-92
FILE: M060ECO.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

Bldg: M060 **Area: 20,856 ft^2**

Run Description	Heating Gas Use (kBtu/yr)	Heating Electric Use (kWh/yr)	Cooling Electric Use (kWh/yr)	Fan Electric Use (kWh/yr)	Pump Electric Use (kWh/yr)	Lighting Electric Use (kWh/yr)	Recept. Electric Use (kWh/yr)	Total Electric Use (kWh/yr)	Peak Electric Demand (kW)	Total Gas Use (MBtu/yr)	Total Energy Use (Mbtu/yr)
Baseline	534,362	3,570	50,115	63,955	22,803	25,412	45,045	210,900	88	534	1,254
ECO#2	432,898	3,140	49,003	63,955	22,803	25,412	45,045	209,358	86	433	1,147
Savings/(Loss)	101,464	430	1,112	0	0	0	0	1,542	2	101	107
ECO#3	516,436	3,445	49,754	63,955	22,803	25,412	45,045	210,413	87	516	1,234
Savings/(Loss)	17,926	126	361	0	0	0	0	487	1	18	20
ECO#12	450,478	3,101	36,635	63,955	21,056	25,412	45,045	195,204	83	450	1,117
Savings/(Loss)	83,884	469	13,480	0	1,747	0	0	15,696	5	84	137
ECO#13	534,362	3,570	59,514	63,955	22,803	25,412	45,045	220,299	66	534	1,286
Savings/(Loss)	0	0	(9,399)	0	0	0	0	(9,399)	22	0	(32)
ECO#15	540,173	3,576	49,501	63,955	22,803	22,618	45,045	207,497	87	540	1,248
Savings/(Loss)	(5,811)	(6)	614	0	0	2,794	0	3,402	1	(6)	6

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: Computer Simulation Summary

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 10-APR-92
FILE: M100ECO.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

Bldg: M100 **Area: 7,393 ft^2**

Run Description	Heating Gas Use (kBtu/yr)	Heating Electric Use (kWh/yr)	Cooling Electric Use (kWh/yr)	Fan Electric Use (kWh/yr)	Pump Electric Use (kWh/yr)	Lighting Electric Use (kWh/yr)	Recept. Electric Use (kWh/yr)	Total Electric Use (kWh/yr)	Peak Electric Demand (kW)	Total Gas Use (MBtu/yr)	Total Energy Use (MBtu/yr)
Baseline	8,311	691	22,050	82,003	1,212	21,272	17,993	145,221	41	8	504
ECO#1 – Wall	19,616	748	23,581	82,003	1,212	21,272	17,993	146,809	41	20	521
Savings/(Loss)	(11,305)	(57)	(1,531)	0	0	0	0	(1,588)	0	(11)	(17)
ECO#1 – Roof	17,513	726	23,974	82,003	1,212	21,272	17,993	147,180	41	18	520
Savings/(Loss)	(9,202)	(35)	(1,924)	0	0	0	0	(1,959)	0	(9)	(16)
ECO#2	9,011	691	22,089	82,003	1,212	21,272	17,993	145,259	41	9	505
Savings/(Loss)	(700)	0	(38)	0	0	0	0	(38)	0	(1)	(1)
ECO#3	8,186	678	22,040	82,003	1,212	21,272	17,993	145,198	41	8	504
Savings/(Loss)	125	13	10	0	0	0	0	23	0	0	0
ECO#12	8,127	161	6,023	28,616	60	21,272	17,993	74,125	36	8	261
Savings/(Loss)	184	530	16,027	53,387	1,152	0	0	71,096	5	0	243
ECO#15	10,150	847	20,341	82,003	1,212	13,186	17,993	135,582	41	10	473
Savings/(Loss)	(1,839)	(156)	1,710	0	0	8,086	0	9,639	0	(2)	31

Building	ECO
100	1R, 1W, 2

This building currently has adequate roof and wall insulation, double-pane window, and acceptable infiltration levels. For purposes of doing take-offs for other buildings, this building was simulated with reduced roof and wall insulation, single-pane windows, and increased infiltration. The results from the new computer simulations were then compared with those from baseline simulation. These differences were then used to calculate the energy factors that were used on the take-off buildings.

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: Computer Simulation Summary

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 10-APR-92
FILE: M168ECO.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

Bldg: M168 **Area: 11,720 ft^2**

Run Description	Heating Gas Use (kBtu/yr)	Heating Electric Use (kWh/yr)	Cooling Electric Use (kWh/yr)	Fan Electric Use (kWh/yr)	Pump Electric Use (kWh/yr)	Lighting Electric Use (kWh/yr)	Recept. Electric Use (kWh/yr)	Total Electric Use (kWh/yr)	Peak Electric Demand (kW)	Total Gas Use (MBtu/yr)	Total Energy Use (MBtu/yr)
Baseline	80,140	1,126	22,484	47,061	33,103	41,081	24,305	169,161	48	80	657
ECO#1 – Roof	29,493	666	19,765	47,061	33,103	41,081	24,305	165,981	44	29	596
Savings/(Loss)	50,647	460	2,720	0	0	0	0	3,180	4	51	61
ECO#3	79,452	1,125	22,476	47,061	33,103	41,081	24,305	169,150	48	79	657
Savings/(Loss)	688	2	8	0	0	0	0	10	0	1	1
ECO#12	61,627	875	16,630	40,030	15,029	41,081	24,305	137,950	46	62	532
Savings/(Loss)	18,513	252	5,854	7,031	2,554	0	0	31,210	2	19	125

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: Computer Simulation Summary

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-APR-92
FILE: M171ECO.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

Bldg: M171 **Area: 35,398 ft^2**

Run Description	Heating Gas Use (kBtu/yr)	Heating Electric Use (kWh/yr)	Cooling Electric Use (kWh/yr)	Fan Electric Use (kWh/yr)	Pump Electric Use (kWh/yr)	Lighting Electric Use (kWh/yr)	Recept. Electric Use (kWh/yr)	Total Electric Use (kWh/yr)	Peak Electric Demand (kW)	Total Gas Use (MBtu/yr)	Total Energy Use (Mbtu/yr)
Baseline	296,389	1,574	65,183	102,491	79,993	93,656	86,156	429,054	161	296	1,760
ECO#7	46,949	185	65,183	102,491	33,743	93,656	86,156	381,414	161	47	1,348
Savings/(Loss)	249,440	1,389	0	0	46,250	0	0	47,639	0	249	412
ECO#12	34,322	96	14,947	35,381	5,427	93,656	86,156	235,663	135	34	838
Savings/(Loss)	262,068	1,478	50,236	67,111	74,566	0	0	193,390	26	262	922
ECO#13	296,389	1,574	81,478	102,491	79,993	93,656	86,156	445,349	101	296	1,816
Savings/(Loss)	0	0	(16,296)	0	0	0	0	(16,296)	60	0	(56)
ECO#15	319,459	1,644	62,248	102,491	79,993	75,862	86,156	408,395	161	319	1,713
Savings/(Loss)	(23,070)	(69)	2,934	0	0	17,794	0	20,659	0	(23)	47

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: Computer Simulation Summary

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 04/22/92
FILE: M181ECO
PREPARED BY: DENNIS JONES
CHECKED BY:

Bldg: M181 Area: 36,158 ft^2

Run Description	Heating Gas Use (kBtu/yr)	Heating Electric Use (kWh/yr)	Cooling Electric Use (kWh/yr)	Fan Electric Use (kWh/yr)	Pump Electric Use (kWh/yr)	Lighting Electric Use (kWh/yr)	Receot. Electric Use (kWh/yr)	Total Electric Use (kWh/yr)	Peak Electric Demand (kW)	Total Gas Use (MBtu/yr)	Total Energy Use (MBtu/yr)
Baseline	212,180	1,447	86,080	273,717	54,369	174,211	92,112	681,936	198	212	2,540
Wall Insulation	103,893	869	81,817	273,166	54,369	174,211	92,112	676,544	195	104	2,413
Savings (Loss)	108,287	578	4,263	551	0	0	0	5,392	3	108	127
Economizer	212,180	1,447	79,882	273,717	54,369	174,211	92,112	675,738	198	212	2,518
Savings (Loss)	0	0	6,198	0	0	0	0	6,198	0	0	21
HVAC Controls	10,306	199	52,098	94,489	18,843	174,211	92,112	431,952	198	10	1,485
Savings (Loss)	201,874	1,248	33,982	179,228	35,526	0	0	249,984	0	202	1,055
Ice Storage	212,180	1,447	120,006	273,717	54,369	174,211	92,112	715,862	146	212	2,655
Savings (Loss)	0	0	(33,926)	0	0	0	0	(33,926)	52	0	(116)

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: Computer Simulation Summary

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 04/21/92
FILE: M184ECO
PREPARED BY: DENNIS JONES
CHECKED BY:

Bldg: M184 Area: 36,158 ft^2

Run Description	Heating Gas Use (kBtu/yr)	Heating Electric Use (kWh/yr)	Cooling Electric Use (kWh/yr)	Fan Electric Use (kWh/yr)	Pump Electric Use (kWh/yr)	Lighting Electric Use (kWh/yr)	Receot. Electric Use (kWh/yr)	Total Electric Use (kWh/yr)	Peak Electric Demand (kW)	Total Gas Use (MBtu/yr)	Total Energy Use (MBtu/yr)
Baseline	127,447	1,015	61,504	137,786	23,652	158,493	92,865	475,315	180	127	1,750
Insulated Glass	86,309	850	59,744	137,786	23,652	158,493	92,865	473,390	176	86	1,702
Savings (Loss)	41,138	165	1,760	0	0	0	0	1,925	4	41	48
Economizer	127,447	1,015	56,767	137,786	23,652	158,493	92,865	470,578	180	127	1,734
Savings (Loss)	0	0	4,737	0	0	0	0	4,737	0	0	16
HW Pump	7,849	63	61,504	137,786	18,359	158,493	92,865	469,070	180	8	1,609
Savings (Loss)	119,598	952	0	0	5,293	0	0	6,245	0	120	141
HVAC Controls	7,849	63	54,264	47,565	5,788	158,493	92,865	359,038	179	8	1,233
Savings (Loss)	119,598	952	7,240	90,221	17,864	0	0	116,277	1	120	516
Ice Storage	127,447	1,015	81,361	137,786	23,652	158,493	92,865	495,172	114	127	1,817
Savings (Loss)	0	0	(19,857)	0	0	0	0	(19,857)	66	0	(68)
Lighting Control	143,681	1,145	56,256	137,786	23,652	128,716	92,865	440,420	180	144	1,647
Savings (Loss)	(16,234)	(130)	5,248	0	0	29,777	0	34,895	0	(16)	103

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: Computer Simulation Summary

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 04/09/92
FILE: M200ECO
PRPARED BY: DENNIS JONES
CHECKED BY:

Bldg: M200 Area: 274,244 ft^2

Run Description	Heating Gas Use (kBtu/yr)	Heating Electric Use (kWh/yr)	Cooling Electric Use (kWh/yr)	Fan Electric Use (kWh/yr)	Pump Electric Use (kWh/yr)	Lighting Electric Use (kWh/yr)	Recept. Electric Use (kWh/yr)	Total Electric Use (kWh/yr)	Peak Electric Demand (kW)	Total Gas Use (MBtu/yr)	Total Energy Use (MBtu/yr)
Baseline	0	22,773	3,538,947	3,261,616	716,492	4,140,593	2,952,151	14,632,572	3,188	0	49,941
Reduced Ventilation	0	20,688	3,543,461	3,261,616	717,486	4,140,593	2,952,151	14,635,995	3,188	0	49,953
Savings (Loss)	0	2,085	(4,514)	0	(994)	0	0	(3,423)	0	0	(12)
Ice Storage	0	22,773	3,400,663	3,261,616	716,492	4,140,593	2,952,151	14,494,288	~~1,713~~	-5'5 0	49,469
Savings (Loss)	0	0	138,284	0	0	0	0	138,284	1,475	0	472
Lighting Controls	0	28,559	3,451,761	3,205,009	715,523	3,518,059	2,952,151	13,871,062	3,025	0	47,342
Savings (Loss)	0	(5,786)	87,186	56,607	969	622,534	0	761,510	163	0	2,599

C-20.9

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION: FORT McPHERSON
ECO: Computer Simulation Summary

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 03/30/92
FILE: M246ECO
PRPARED BY: DENNIS JONES
CHECKED BY:

Bldg: M246 Area: 23,072 ft^2

Run Description	Heating Gas Use (kBtu/yr)	Heating Electric Use (kWh/yr)	Cooling Electric Use (kWh/yr)	Fan Electric Use (kWh/yr)	Pump Electric Use (kWh/yr)	Lighting Electric Use (kWh/yr)	Recept. Electric Use (kWh/yr)	Total Electric Use (kWh/yr)	Peak Electric Demand (kW)	Total Gas Use (MBtu/yr)	Total Energy Use (MBtu/yr)
Baseline	47,364	1,057	53,680	231,647	17,958	105,413	44,082	453,837	139	47	1,596
Economizer	47,364	1,057	52,110	231,647	17,958	105,413	44,082	452,267	139	47	1,591
Savings (Loss)	0	0	1,570	0	0	0	0	1,570	0	0	5
HVAC Controls	5,293	52	37,376	79,966	5,537	105,413	44,082	272,426	139	5	935
Savings (Loss)	42,071	1,005	16,304	151,681	12,421	0	0	181,411	0	42	661
Lighting (15% reduction)	54,491	1,183	50,722	231,647	17,958	89,441	44,082	435,033	130	54	1,539
Savings (Loss)	(7,127)	(126)	2,958	0	0	15,972	0	18,804	9	(7)	57
Ice Storage	47,364	1,057	73,527	231,647	17,958	105,413	44,082	473,684	56	47	1,664
Savings (Loss)	0	0	(19,847)	0	0	0	0	(19,847)	83	0	(68)

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: Computer Simulation Summary

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 13-APR-92
FILE: M358ECO.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

Bldg: M358 **Area: 16,110 ft^2**

Run Description	Heating Gas Use (kBtu/yr)	Heating Electric Use (kWh/yr)	Cooling Electric Use (kWh/yr)	Fan Electric Use (kWh/yr)	Pump Electric Use (kWh/yr)	Lighting Electric Use (kWh/yr)	Recept. Electric Use (kWh/yr)	Total Electric Use (kWh/yr)	Peak Electric Demand (kW)	Total Gas Use (MBtu/yr)	Total Energy Use (Mbtu/yr)
Baseline	9,738	285	41,175	23,857	17,060	89,217	42,448	214,043	111	10	740
ECO#2	41,052	541	40,715	23,857	17,060	89,217	42,448	213,838	111	41	771
Savings/(Loss)	(31,313)	(255)	460	0	0	0	0	205	0	(31)	(31)
ECO#3	9,741	285	41,179	23,857	17,060	89,217	42,448	214,046	111	10	740
Savings/(Loss)	(2)	0	(4)	0	0	0	0	(4)	0	(0)	(0)
ECO#12	2,938	24	18,998	20,022	2,987	89,217	42,448	173,695	96	3	596
Savings/(Loss)	6,800	262	22,178	3,835	14,073	0	0	40,348	15	7	144

Building	ECO
358	2

This building currently has adequate roof and wall insulation, double-pane window, and acceptable infiltration levels. For purposes of doing take-offs for other buildings, this building was simulated with reduced roof and wall insulation, single-pane windows, and increased infiltration. The results from the new computer simulations were then compared with those from baseline simulation. These differences were then used to calculate the energy factors that were used on the take-off buildings.

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: Computer Simulation Summary

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 10-APR-92
FILE: M500ECO.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

Bldg: M500 **Area: 27,466 ft^2**

Run Description	Heating Gas Use (kBtu/yr)	Heating Electric Use (kWh/yr)	Cooling Electric Use (kWh/yr)	Fan Electric Use (kWh/yr)	Pump Electric Use (kWh/yr)	Lighting Electric Use (kWh/yr)	Recept. Electric Use (kWh/yr)	Total Electric Use (kWh/yr)	Peak Electric Demand (kW)	Total Gas Use (MBtu/yr)	Total Energy Use (Mbtu/yr)
Baseline	522,953	2,949	72,756	244,089	33,103	60,842	142,768	556,507	159	523	2,422
ECO#2	542,100	3,015	72,788	244,089	33,103	60,842	142,768	556,606	161	542	2,441
Savings/(Loss)	(19,148)	(66)	(33)	0	0	0	0	(99)	(2)	(19)	(19)
ECO#3	523,838	2,952	72,771	244,089	33,103	60,842	142,768	556,526	161	524	2,423
Savings/(Loss)	(886)	(3)	(16)	0	0	0	0	(19)	(2)	(1)	(1)
ECO#7	144,716	1,073	63,409	244,089	10,647	60,842	142,768	522,828	159	145	1,929
Savings/(Loss)	378,236	1,876	9,347	0	22,456	0	0	33,679	0	378	493
ECO#12	109,736	1,030	52,295	115,273	10,302	60,842	142,768	382,510	155	110	1,415
Savings/(Loss)	413,217	1,919	20,460	128,816	22,801	0	0	173,997	4	413	1,007
ECO#13	522,953	2,949	85,878	244,089	33,103	60,842	142,768	569,629	113	523	2,467
Savings/(Loss)	0	0	(13,122)	0	0	0	0	(13,122)	46	0	(45)

Building	ECO
500	2, 3

This building currently has adequate roof and wall insulation, double-pane window, and acceptable infiltration levels. For purposes of doing take-offs for other buildings, this building was simulated with reduced roof and wall insulation, single-pane windows, and increased infiltration. The results from the new computer simulations were then compared with those from baseline simulation. These differences were then used to calculate the energy factors that were used on the take-off buildings.

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: Computer Simulation Summary

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 10-APR-92
FILE: M514ECO.WK3
PREPARED BY: JIM WATTERS
CHECKED BY:

Bldg: M514 **Area: 9,744 ft^2**

Run Description	Heating Gas Use (kBtu/yr)	Heating Electric Use (kWh/yr)	Cooling Electric Use (kWh/yr)	Fan Electric Use (kWh/yr)	Pump Electric Use (kWh/yr)	Lighting Electric Use (kWh/yr)	Recept. Electric Use (kWh/yr)	Total Electric Use (kWh/yr)	Peak Electric Demand (kW)	Total Gas Use (MBtu/yr)	Total Energy Use (Mbtu/yr)
Baseline	23,160	1,165	22,984	68,724	0	52,797	5,400	151,070	46	23	539
ECO#6	23,160	1,165	21,783	68,724	0	52,797	5,400	149,868	46	23	535
Savings/(Loss)	0	0	1,202	0	0	0	0	1,202	0	0	4
ECO#12	5,964	142	3,721	23,725	0	52,797	5,400	85,784	41	6	299
Savings/(Loss)	17,196	1,023	19,263	44,999	0	0	0	65,286	5	17	240

APPENDIX D

ECO PROJECT BACKUP CALCULATIONS

D-1 ECIP PROJECT
D-2 QRIP PROJECT
D-3 FAMILY HOUSING PROJECT
D-4 NAF PROJECT
D-5 OTHER ENERGY PROJECTS

APPENDIX D-1 ECIP PROJECTS

ECO-1, ADD ROOF INSULATION
ECO-1, ADD PIPE AND DUCT INSULATION
ECO-7, CONTROL HOT WATER CIRCULATION PUMPS
ECO-11, REPLACE STREET LIGHTS
ECO-12, REVISE OR REPAIR HVAC CONTROLS
ECO-15, LIGHTING CONTROLS IN BUILDING 200
ECO-18, REPLACE EXIT SIGN BULBS WITH FLUORESCENT BULB KITS
ECO-19, PREVIOUS LIGHTING REVIEW STUDY, FOR LIGHT FIXTURE REPLACEMENTS

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: MPJ1
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECIP PROJECT
ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	1029747.
B. SIOH	$	56636.
C. DESIGN COST	$	61785.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	1148168.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	12604.	$ 94167.	11.11	1046198.
B. DIST	$ .00	0.	$ 0.	14.26	0.
C. RESID	$ .00	0.	$ 0.	16.89	0.
D. NAT G	$ 4.67	1818.	$ 8490.	14.45	122681.
E. COAL	$ .00	0.	$ 0.	11.21	0.
F. TOTAL		14422.	$ 102657.		$ 1168880.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 91688.
(1) DISCOUNT FACTOR (TABLE A) 10.59
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 970976.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 970976.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 385730.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) 1.35
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 194345.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 2139856.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.86
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 5.91

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECIP PROJECT

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 01-Sep-92
FILE: FNLECO.WK3
PREPARED BY: CMD
CHECKED BY: CEL

	ENERGY COST	25-YR DISCOUNT FACTOR	15-YR DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	23.77 UPWG	14.45 UPWG
Electric Savings	$0.0255 / kWh	15.61 UPWE	11.11 UPWE
Demand Savings	$8.85 / kW	14.53 UPW	10.59 UPW

PROJECT ECONOMIC LIFE 15 YEARS

ECO #	ECONOMIC LIFE (yrs)	ANNUAL/ PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON-ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
ECO-1P	25	0	4	177	177	$827	$0	$0	$827	$6,766	2.9	8.2
ECO-1R	25	4	3,164	51	62	$319	$406	$0	$724	$3,791	3.4	5.2
ECO-1D	25	0	12,929	119	163	$883	$0	$0	$883	$4,065	4.5	4.6
ECO-7	15	0	95,278	498	823	$4,755	$0	$0	$4,755	$22,006	2.8	4.6
ECO-11	25	0	43,362	0.00	148	$1,110	$0	$417	$1,527	$6,917	3.4	4.5
ECO-12	15	89	1,206,665	973	5,087	$35,313	$9,095	$1,016	$45,423	$227,602	2.3	5.0
ECO-15-B200	25	163	761,510	0.00	2,599	$19,419	$16,734	$0	$36,152	$142,464	3.8	3.9
ECO-18	25	12	102,755	0.00	351	$2,631	$1,204	($1,181)	$2,654	$16,567	2.5	6.2
ECO-19	25	627	1,467,180	0.00	5,003	$37,413	$64,368	$0	$101,781	$718,703	2.1	7.1
TOTAL		895	3,692,847	1,818	14,413	$102,669	$91,807	$252	$194,726	$1,148,881	1.9	5.9

ECO-1, ADD ROOF INSULATION

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: MECO1
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-1 ROOF INSULATION
ANALYSIS DATE: 07-09-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	3400.
B. SIOH	$	187.
C. DESIGN COST	$	204.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	3791.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	11.	$ 81.	15.61	1260.
B. DIST	$ .00	0.	$ 0.	21.66	0.
C. RESID	$ .00	0.	$ 0.	26.51	0.
D. NAT G	$ 4.67	51.	$ 238.	23.77	5661.
E. COAL	$ .00	0.	$ 0.	16.06	0.
F. TOTAL		62.	$ 319.		$ 6921.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 406.
(1) DISCOUNT FACTOR (TABLE A) 14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 5899.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 5899.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 2284.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) 2.43
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 725.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 12820.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 3.38
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 5.23

ROOF INSULATION SAMPLE CALCULATION, ECO #1
BUILDING 111

Given:

Roof Area	= 2,150 ft^2	- from bldg plans
Existing Roof U-value	= 0.202 Btuh / hr °F ft^2	- from survey notes
Improved Roof U-value	= 0.042 Btuh / hr °F ft^2	- from survey notes
Gas Savings Factor	= 0.0083 MBtu / UA	- from Bldg 100 simulation
Electric Savings Factor	= 1.8 kWh / UA	- from Bldg 100 simulation
Demand Savings Factor	= 0.0 kW	- from Bldg 100 simulation
Gas Cost	= $4.67 / MBtu	- from utility rate analysis
Electric Cost	= $0.0255 / kWh	- from utility rate analysis
Demand Cost	= $8.85 / kW	- from utility rate analysis

Existing Roof UA:

(2,150 ft^2)*(0.202 Btuh / hr °F ft^2) = 434.3 Btuh / hr °F

Improved Roof UA:

(2,150 ft^2)*(0.042 Btuh / hr °F ft^2) = 90.3 Btuh / hr °F

Delta UA:

434.3 - 90.3 = 344.0 Btuh / hr °F

Peak Demand Savings:

(344.0 UA)*(0.0 kW / UA) = 0.0 kW

Annual Energy Savings:

- Gas:	(344.0 UA)*(0.0083 MBtu / UA)	= 2.9 MBtu
- Electric:	(344.0 UA)*(1.8 kWh / UA)	= 619 kWh

Annual Cost Savings:

(2.9 MBtu)*($4.67 / MBtu) + (619 kWh)*($0.0255 / kWh) + (0.0 kW)*($8.85 / kW)*(4 + .95 * 8) = $29 / yr

Estimated Construction Cost:

$0.68 / ft^2 of wall - from engineer's cost estimate

($0.68 / ft^2)*(2,150 ft^2) = $1,462

$1,462 + ($1,462 * .055 SIOH) + ($1,462 * .06 DESIGN) = $1,630

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 1 – Roof Insulation

CLIENT CONTRACT NO: DACA21–91–C–0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15–APR–92
FILE: ECO–1R.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	23.77 UPWG
Electric Savings	$0.0255 / kWh	15.61 UPWE
Demand Savings	$8.85 / kW	14.53 UPW

Economic Life: 25 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON–ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
168	4	3,164	51	62	$318	$406	$0	$724	$3,791	3.4	5.2
TOTAL	4	3,164	51	62	$318	$406	$0	$724	$3,791	3.4	5.2
111	0	619	3	5	$29	$0	$0	$29	$1,462	0.3	50.2
112	0	619	3	5	$29	$0	$0	$29	$1,462	0.3	50.2
114	0	619	3	5	$29	$0	$0	$29	$1,462	0.3	50.2

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 1 – Roof Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-APR-92
FILE: ECO-1R.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG #	ROOF AREA (ft^2)	EXIST ROOF U-VALUE	EXIST ROOF UA	IMPRVD ROOF U-VALUE	IMPRVD ROOF UA	DELTA UA	DEMAND SAVINGS (kW/UA)	ELECTRIC SAVINGS (kWh/UA)	GAS SAVINGS (MBtu/UA)	PEAK DEMAND SAVINGS (kW/yr)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	UNIT CONST COST ($/$ft^2$)	CONST COST ($)
111	2150	0.202	434.3	0.042	90.3	344.0	0	1.8	0.0083	0	619	2.9	$0.68	$1,462
112	2150	0.202	434.3	0.042	90.3	344.0	0	1.8	0.0083	0	619	2.9	$0.68	$1,462
114	2150	0.202	434.3	0.042	90.3	344.0	0	1.8	0.0083	0	619	2.9	$0.68	$1,462
168	5000	0.270	1350.0	0.044	220.0	1130.0	0.0035	2.8	0.045	4.0	3,164	50.9	$0.68	$3,400

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study LOCATION Ft. McPherson & Ft Gillem	INVITATION NO./CONTRACT NO. DACA 21-91-C-0097 X CODE A ☐ CODE B ☐ CODE C ☐ OTHER ______	EFFECTIVE PRICING DATE APR 92 DRAWING NO. ESTIMATOR RMG	DATE PREPARED 15-Apr-92 SHT OF CHECKED BY

ECO 1 - Roof	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
FIBERGLASS BATTS, R-19	1	SF	0.005	0.005	$18.53	$0.09			$0.38	$0.38	$0.47		
SUBTOTAL											$0.47		
OVERHEAD, BOND	15%										$0.07		
PROFIT	10%										$0.05		
COST SUB-TOTAL											$0.59		
CONTINGENCY	15%										$0.09		
SUBTOTAL											$0.68		
S&A													
TOTAL											$0.68		

DA FORM 5418-R, APR 85

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

EFFECTIVE PRICING DATE APR 92

DATE PREPARED 16-Apr-92

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

X CODE A CODE B CODE C OTHER

DRAWING NO.

SHT OF

ESTIMATOR RMG

CHECKED BY

ECO 1 – Roof, Warehouse	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
ISOCYANURATE, FOIL FACED, 3" THICK	1	SF	0.011	0.011	$18.53	$0.20			$1.49	$1.49	$1.69		
AERIAL LIFT, TELESCOPING BOOM	0.011	HR					$5.60	$0.06			$0.06		
SUBTOTAL											$1.76		
OVERHEAD, BOND	15%										$0.26		
PROFIT	10%										$0.18		
COST SUB-TOTAL											$2.19		
CONTINGENCY	15%										$0.33		
SUBTOTAL											$2.52		
S&A													
TOTAL											$2.52		

DA FORM 5418-R, APR 85

ECO-1, ADD PIPE AND DUCT INSULATION

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: MECO1
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-1A- DUCT INSULATION
ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	3646.
B. SIOH	$	201.
C. DESIGN COST	$	219.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	4066.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	44.	$ 329.	15.61	5132.
B. DIST	$ .00	0.	$ 0.	21.66	0.
C. RESID	$ .00	0.	$ 0.	26.51	0.
D. NAT G	$ 4.67	119.	$ 556.	23.77	13210.
E. COAL	$ .00	0.	$ 0.	16.06	0.
F. TOTAL		163.	$ 884.		$ 18341.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 6053.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 884.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 18341.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 4.51
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 4.60

DUCT INSULATION SAMPLE CALCULATION, ECO #1
BUILDING G101

Given:

Duct Perimeter	= 80 in	- from bldg plans / survey notes
Duct Length	= 45 ft	- from bldg plans / survey notes
Existing Ins. Thickness	= 0.5 in	- from survey notes
Improved Ins. Thickness	= 2.0 in	- assumed
Ins. Thermal Cond.	= 0.26 Btuh in / ft^2 °F	- from ASHRAE
Inner Film R-Value	= 0.22 ft^2 °F / Btuh	- from ASHRAE
Outer Film R-Value	= 0.65 ft^2 °F / Btuh	- from ASHRAE
Duct Temp. -Heating	= 90 °F	- assumed
Duct Temp. -Cooling	= 55 °F	- assumed
Amb. Temp. Winter	= 75 °F	- assumed
Amb. Temp. Summer	= 90 °F	- assumed
Delta Enthalpy - Summer	= 15.6 Btu / lbm	- assumed
Leakage Class w/o insul.	= 48 cfm / 100ft^2	- SMACNA *
Leakage Class w/ added insul	= 24 cfm / 100 ft^2	- SMACNA *
Static Pressure	= 0.5 in. w.g.	- assumed
Gas Heater Efficiency	= 75%	- assumed
Gas Cost	= $4.67 / MBtu	- from utility rate analysis
Electric Cost	= $0.0255 / kWh	- from utility rate analysis
Demand Cost	= $8.85 / kW	- from utility rate analysis

* Per SMACNA "HVAC Systems Duct Design," 1990- Third Edition

Duct Surface Area:

(80 in / 12 in / ft)*(45 ft) = 300 ft^2

Existing Insulation R-Value:

1 / ((0.26 Btuh in / ft^2 °F) / (0.5 in)) = 1.92 ft^2 °F / Btuh

Existing U-Value:

1 / (0.22 + 1.92 + 0.65 ft^2 °F / Btuh) = 0.36 Btuh / ft^2 °F

Improved Insulation R-Value:

1 / ((0.26 Btuh in / ft^2 °F) / (2.0 in)) = 7.69 ft^2 °F / Btuh

Improved U-Value:

1 / (0.22 + 7.69 + 0.65 ft^2 °F / Btuh) = 0.12 Btuh / ft^2 °F

Existing Leakage Rate:

(48 cfm / 100 ft^2)*$(0.5)^{0.65}$ = 30.6 cfm / 100 ft^2

Total Leakage

$(30.6 \text{ cfm} / 100 \text{ ft}^2) * (300 \text{ ft}^2) = 91.8 \text{ cfm}$

Improved Leakage Rate

$(24 \text{ cfm} / 100 \text{ ft}^2) * (0.5)^{0.65} = 15.3 \text{ cfm} / 100 \text{ ft}^2$

Total Leakage

$(15.3 \text{ cfm} / 100 \text{ ft}^2) * (300 \text{ ft}^2) = 45.9 \text{ cfm}$

Existing Energy Usage:

Winter (gas):

Insulation

$(0.36 \text{ Btuh} / \text{ft}^2\ °\text{F})*(300 \text{ ft}^2)*(90 - 75\ °\text{F}) / 0.75 = 2{,}160 \text{ Btuh}$

Leakage

$$\frac{(1.1 \text{ Btuh} / \text{cfm}\ °\text{F}) * (91.8 \text{ cfm})(90 - 75\ °\text{F})}{0.75} = 2020 \text{ Btuh}$$

Total

$(2020 + 2160) = 4180 \text{ Btuh}$
$(4180 \text{ Btuh}) * (4380 \text{ hrs}) = 18.3 \text{ MBtu}$

Summer (electric):

Insulation

$(0.36 \text{ Btuh} / \text{ft}^2\ °\text{F})*(300 \text{ ft}^2)*(90 - 55\ °\text{F})*(5.83\text{E-}5 \text{ kW} / \text{Btuh}) = 0.22 \text{ kW}$

Leakage

$(4.5 \text{ lbm} / \text{cfm hr}) + (91.8 \text{ cfm}) * (15.6 \text{ Btu} / \text{lbm}) * (5.83\text{E-}5 \text{ kw} / \text{Btuh}) = 0.38 \text{ kw}$

Total

$(0.22 + 0.38) = 0.60 \text{ kw}$
$(0.60 \text{ kw}) * (4380 \text{ hrs}) = 2628 \text{ kwh}$

Improved Energy Usage:

Winter (gas):

Insulation

(0.12 Btuh / ft² °F)*(300 ft²)*(90 - 75 °F) / 0.75 = 701 Btuh

Leakage

$$\frac{(1.1 \text{ Btuh / cfm °F}) * (45.9 \text{ cfm})(90 - 75 \text{ °F}}{0.75} = 1010 \text{ Btuh}$$

Total

(7.1 + 1010) = 1711 Btuh
(1711 Btuh) * (4380 hrs) = 7.5 MBtu

Summer (electric):

Insulation

(0.12 Btuh / ft² °F)*(300 ft²)*(90 - 55 °F)*(5.83E-5 kW / Btuh)= 0.071 kW

Leakage

(4.5 lbm / cfm hr) * (45.9 cfm) (15.6 Btu / lbm) * (5.83E-5 kw / Btuh)= 0.19 kw

Total

(0.071 + 0.19) = 0.26 kw
(0.26 kw) * (4380 yrs) = 1134 kwh

Peak Demand Savings: 0 kW

Annual Energy Savings:

- Electric:	(2628 - 1134 kWh)	= 1494 kW
- Gas:	(18.3 - 7.5 MBtu)	= 10.8 MBtu

Annual Cost Savings:

(10.8 MBtu)*($4.67 / MBtu) + (1494 kWh)*($0.0255 / kWh) + (0 kW)*($8.85 / kW)*(4 + .95 * 8) = $89 / yr

Estimated Construction Cost:

$3.05 / ft² of insulation - from engineer's cost estimate

($3.05 / ft²)*(300 ft²) = $915

$915 + ($915 * .055 SIOH) + ($915 * .06 DESIGN) = $1,020

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 1 – Duct Insulation

EMC PROJECT: #3105.000
DATE: 15–Jul–92
FILE: ECO–1D.WK3
PREPARED BY: CMD
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21–91–C–0097
CLIENT PROJECT ENG: TERRY SEABROOK

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	23.77 UPWG
Electric Savings	$0.0255 / kWh	15.61 UPWE
Demand Savings	$8.85 / kW	14.53 UPW

Economic Life: 25 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON–ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
42	0	5,620	51.74	71	$385	$0	$0	$385	$1,767	4.5	4.6
105	0	301	2.77	4	$21	$0	$0	$21	$96	4.5	4.6
358	0	7008	64	88	$478	$0	$0	$478	$2,202	4.5	4.6
TOTAL	0	12929	119	163	$883	$0	$0	$883	$4,065	4.5	4.6

LIFE CYCLE COST ANALYSIS SUMMARY   STUDY: MECO1
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)   LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-1A PIPE INSULATION
ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	6068.
B. SIOH	$	334.
C. DESIGN COST	$	364.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	6766.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	0.	$ 0.	15.61	0.
B. DIST	$ .00	0.	$ 0.	21.66	0.
C. RESID	$ .00	0.	$ 0.	26.51	0.
D. NAT G	$ 4.67	177.	$ 827.	23.77	19648.
E. COAL	$ .00	0.	$ 0.	16.06	0.
F. TOTAL		177.	$ 827.		$ 19648.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 6484.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 827.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 19648.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 2.90
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 8.19

PIPE INSULATION SAMPLE CALCULATION, ECO #1
BUILDING G101

Given:

Pipe Diameter	= 2.0 in	- from bldg plans / survey notes
Pipe Length	= 100 ft	- from bldg plans / survey notes
Existing Ins. Thickness	= 1.0 in	- from survey notes
Improved Ins. Thickness	= 1.5 in	- assumed
Ins. Thermal Cond.	= 0.26 Btuh in / ft² °F	- from ASHRAE
Fluid Temperature	= 140 °F	- assumed
Amb. Temperature	= 50 °F	- assumed
Gas Boiler Efficiency	= 75%	- assumed
Gas Cost	= $4.67 / MBtu	- from utility rate analysis
Electric Cost	= $0.0255 / kWh	- from utility rate analysis
Demand Cost	= $8.85 / kW	- from utility rate analysis

Existing Conductance Coefficient:

ln((2 + 2 * 1.0)/2)/(2 * pi *((0.26 Btuh in / ft² °F)/(12 in / ft))
= 5.09 ft °F / Btuh

Existing Pipe Surface Temperature:

assume Rc = 1 ft °F / Btuh

(50 °F) + (140 - 50 °F)*(1 ft °F / Btuh)/(1 + 5.09 ft °F / Btuh)
= 64.8 °F

Existing Convection Coefficient:

hc = 0.18*(64.8 - 40)^0.33 = 0.52 Btuh / ft² °F
A = pi * 2 in * (1 ft / 12 in) = 0.52 ft² / ft

1 / ((0.52 Btuh / ft² °F)*(0.52 ft² / ft)) = 3.68 ft °F / Btuh

After 5 iterations:

Ts = 74.1 °F
Rc = 1.86 ft °F / Btuh

Existing Combined Coefficient of Resistance:

5.09 + 1.86 = 6.95 ft °F / Btuh

Existing Annual Energy Loss:

(140 - 50 °F)*(100 ft) /((6.95 ft °F / Btuh)*(0.75)) = 1,727 Btuh

$(1,727\ \text{Btuh})*(4,380\ \text{hrs/yr}) = 7.6\ \text{MBtu/yr}$

Improved Conductance Coefficient:

$\ln((2 + 2 * 1.5)/2)/(2 * \pi *((0.26\ \text{Btuh in / ft}^2\ °\text{F})/(12\ \text{in / ft}))$
$= 6.73\ \text{ft °F / Btuh}$

Improved Pipe Surface Temperature:

assume $Rc = 1$ ft °F / Btuh

$(50\ °\text{F}) + (140 - 50\ °\text{F})*(1\ \text{ft °F / Btuh})/(1 + 6.73\ \text{ft °F / Btuh})$
$= 61.6\ °\text{F}$

Improved Convection Coefficient:

$hc = 0.18*(61.6 - 40)\hat{}0.33 = 0.50\ \text{Btuh / ft}^2\ °\text{F}$
$A = \pi * 2\ \text{in} * (1\ \text{ft} / 12\ \text{in}) = 0.52\ \text{ft}^2 / \text{ft}$

$1 / ((0.50\ \text{Btuh / ft}^2\ °\text{F})*(0.52\ \text{ft}^2 / \text{ft})) = 3.85\ \text{ft °F / Btuh}$

After 5 iterations:

$Ts = 67.7\ °\text{F}$
$Rc = 1.65$ ft °F / Btuh

Improved Combined Coefficient of Resistance:

$6.73 + 1.65 = 8.38$ ft °F / Btuh

Improved Energy Loss:

$(140 - 50\ °\text{F})*(100\ \text{ft}) / ((8.38\ \text{ft °F / Btuh})*(0.75)) = 1,431\ \text{Btuh}$
$(1,431\ \text{Btuh})*(4,380\ \text{hrs/yr}) = 6.3\ \text{MBtu/yr}$

Peak Demand Savings: 0 kW

Annual Energy Savings:

- Electric:		= 0 kW
- Gas:	(7.6 - 6.3 MBtu)	= 1.3 MBtu

Annual Cost Savings:

$(1.3\ \text{MBtu})*(\$4.67 / \text{MBtu}) + (0\ \text{kWh})*(\$0.0255 / \text{kWh}) + (0\ \text{kW})*(\$8.85 / \text{kW})*(4 + .95 * 8) = \$6 / \text{yr}$

Estimated Construction Cost:

$4.57 / ft of 1-1/2" insulation on 2" pipe - from engineer's cost estimate

($4.57 / ft)*(100 ft) = $457

1,334 -small construction cost

$457 + $1,334 = $1791

$1791 + ($1791 * .055 SIOH) + ($1791 * .06 DESIGN) = $1,997

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 1 – Pipe Insulation

CLIENT CONTRACT NO: DACA21–91–C–0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 14–Jul–92
FILE: ECO–1.WK3
PREPARED BY: CMD
CHECKED BY: CEL

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	23.77 UPWG
Electric Savings	$0.0255 / kWh	15.61 UPWE
Demand Savings	$8.85 / kW	14.53 UPW

Economic Life: 25 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON–ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
111	0	4	12.37	12	$58	$0	$0	$58	155.38	8.8	2.7
61	0	0	105.17	105	$491	$0	$0	$491	3563.54	3.3	7.3
112	0	0	59.60	60	$278	$0	$0	$278	3047.34	2.2	10.9
TOTAL	0	4	177	177	$827	$0	$0	$827	$6,766	2.9	8.2

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: DUCT AND PIPE INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 02-Sep-92
FILE: MDUCTPIP.WK3
PREPARED BY: CMD
CHECKED BY: CEL

HOT WATER PIPES

BLDG #	PIPE DIA. (IN)	LENGTH (FT)	SURVEY		REQUIRED INSULATION (IN)	REMARKS
			THICKNESS (IN)	TYPE		
22	1.5	150	0.5	Rubber	1.5	
27	2	250	1	Fiberglass	1.5	DTW Pipe
	1.25	200	1	Fiberglass	1.5	DTW Pipe
28	2	250	1	Fiberglass	1.5	DTW Pipe
	1.25	200	1	Fiberglass	1.5	DTW Pipe
40	4	50	0.5	Rubber	1.5	
	1.5	200	0.75	Fiberglass	1.5	
41	3	150	0.5	Rubber	1.5	
	2	50	0.5	Rubber	1.5	
42	1.5	40	1	Fiberglass	1.5	DTW Pipe
61	2	100	1	Fiberglass	1.5	
	4	85	2	Foam	1.5	
	3	90	1	Fiberglass	1.5	
100	3.5	200	1	Fiberglass	1.5	
101	4	25	1.5	Fiberglass	1.5	
102	N/A	–	–	–	–	
105	N/A	–	–	–	–	
109	2.5	50	1	Fiberglass	1.5	
111	2	15	0	–	1.5	
112	N/A	–	–	–	–	
114	N/A	–	–	–	–	
116	N/A					
117	2	10	1.25	Rubber	1.5	DTW Pipe
	2	15	0.5	Rubber	1.5	
	2	4	0	–	1.5	
118	N/A	–	–	–	–	
124	N/A	–	–	–	–	
155	N/A	–	–	–	–	
178	N/A	–	–	–	–	
179	3	180	1	Rubber	1.5	DTW Pipe
	2	30	1	Rubber	1.5	DTW Pipe
358	3	40	1.75	Foam	1.5	
	1.5	40	0.75	Rubber	1.5	
	1.5	200	2	Fiberglass	1.5	
	1.5	25	0.75	Rubber	1.5	
	1.25	30	1	Rubber	1.5	
360	2	50	0	–	1.5	
400	N/A	–	–	–	–	
522	1.5	150	1	Fiberglass	1.5	

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

EMC PROJECT: #3105.000
DATE: 17-Apr-92

ECO: DUCT AND PIPE INSULATION

FILE: MDUCTPIP.WK3
PREPARED BY: CMD
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

HOT WATER PIPES

BLDG #	PIPE DIA. (IN)	LENGTH (FT)	SURVEY		REQUIRED INSULATION (IN)	REMARKS
			THICKNESS (IN)	TYPE		
22	1.5	150	0.5	Rubber	1.5	
27	2	250	1	Fiberglass	1.5	DTW Pipe
	1.25	200	1	Fiberglass	1.5	DTW Pipe
28	2	250	1	Fiberglass	1.5	DTW Pipe
	1.25	200	1	Fiberglass	1.5	DTW Pipe
40	4	50	0.5	Rubber	1.5	
	1.5	200	0.75	Fiberglass	1.5	
41	3	150	0.5	Rubber	1.5	
	2	50	0.5	Rubber	1.5	
42	1.5	40	1	Fiberglass	1.5	DTW Pipe
61	2	100	1	Fiberglass	1.5	
	4	85	2	Foam	1.5	
	3	90	1	Fiberglass	1.5	
100	3.5	200	1	Fiberglass	1.5	
101	4	25	1.5	Fiberglass	1.5	
102	N/A	–	–	–	–	
105	N/A	–	–	–	–	
109	2.5	50	1	Fiberglass	1.5	
111	2	15	0	–	1.5	
112	N/A	–	–	–	–	
114	N/A	–	–	–	–	
116	N/A					
117	2	10	1.25	Rubber	1.5	DTW Pipe
	2	15	0.5	Rubber	1.5	
	2	4	0	–	1.5	
118	N/A	–	–	–	–	
124	N/A	–	–	–	–	
155	N/A	–	–	–	–	
178	N/A	–	–	–	–	
179	3	180	1	Rubber	1.5	DTW Pipe
	2	30	1	Rubber	1.5	DTW Pipe
358	3	40	1.75	Foam	1.5	
	1.5	40	0.75	Rubber	1.5	
	1.5	200	2	Fiberglass	1.5	
	1.5	25	0.75	Rubber	1.5	
	1.25	30	1	Rubber	1.5	
360	2	50	0	–	1.5	
400	N/A	–	–	–	–	
522	1.5	150	1	Fiberglass	1.5	

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: DUCT AND PIPE INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 02-Sep-92
FILE: MDUCTPIP.WK3
PREPARED BY: CAMERAN DIBAI
CHECKED BY: CEL

STEAM PIPES

BLDG #	PIPE DIA. (IN)	LENGTH (FT)	SURVEY THICKNESS (IN)	SURVEY TYPE	REQUIRED INSULATION (IN)	REMARKS
22	N/A	–	–	–	–	
27	N/A	–	–	–	–	
28	N/A	–	–	–	–	
40	5	35	2	Fiberglass	3.5	Low Press.
	1	20	1	Fiberglass	1.5	Condensate
41	N/A	–	–	–	–	
42	N/A	–	–	–	–	
61	2	40	1	Fiberglass	1.5	Condensate
	4	50	1.5	Fiberglass	2.5	Low Press.
	3	60	1	Fiberglass	2.5	Low Press.
	2	10	0	–	2.5	
	1	10	0	–	1.5	Condensate
	2	70	1.5	Fiberglass	2.5	
	1.5	40	0	–	1.5	Condensate
	3	40	1	Fiberglass	1.5	Low Press.
100	N/A	–	–	–	–	
101	N/A	–	–	–	–	
102	N/A	–	–	–	–	
105	N/A	–	–	–	–	
109	N/A	–	–	–	–	
111	N/A	–	–	–	–	
112	4	25	0.75	Fiberglass	3	
	3	6	0	–	2.5	Fiberglass
	3.5	38	1	Fiberglass	3	
	2	185	1	Fiberglass	1.5	Condensate
	1.5	185	1	Fiberglass	2.5	
114	N/A	–	–	–	–	
116	N/A					
117	N/A	–	–	–	–	Fiberglass
118	N/A	–	–	–	–	
155	3.5	200	0	–	3	
	1	200	0	–	1.5	Condensate
178	N/A	–	–	–	–	
179	N/A	–	–	–	–	
358	N/A	–	–	–	–	
360	N/A	–	–	–	–	
400	N/A	–	–	–	–	
522	N/A	–	–	–	–	

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: DUCT AND PIPE INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 17-Apr-92
FILE: MDUCTPIP.WK3
PREPARED BY: CAMERAN DIBAI
CHECKED BY: CEL

STEAM PIPES

BLDG #	PIPE DIA. (IN)	LENGTH (FT)	SURVEY		REQUIRED INSULATION (IN)	REMARKS
			THICKNESS (IN)	TYPE		
22	N/A	–	–	–	–	
27	N/A	–	–	–	–	
28	N/A	–	–	–	–	
40	5	35	2	Fiberglass	3.5	Low Press.
	1	20	1	Fiberglass	1.5	Condensate
41	N/A	–	–	–	–	
42	N/A	–	–	–	–	
61	2	40	1	Fiberglass	1.5	Condensate
	4	50	1.5	Fiberglass	2.5	Low Press.
	3	60	1	Fiberglass	2.5	Low Press.
	2	10	0	–	2.5	
	1	10	0	–	1.5	Condensate
	2	70	1.5	Fiberglass	2.5	
	1.5	40	0	–	1.5	Condensate
	3	40	1	Fiberglass	1.5	Low Press.
100	N/A	–	–	–	–	
101	N/A	–	–	–	–	
102	N/A	–	–	–	–	
105	N/A	–	–	–	–	
109	N/A	–	–	–	–	
111	N/A	–	–	–	–	
112	4	25	0.75	Fiberglass	3	
	3	6	0	–	2.5	Fiberglass
	3.5	38	1	Fiberglass	3	
	2	185	1	Fiberglass	1.5	Condensate
	1.5	185	1	Fiberglass	2.5	
114	N/A	–	–	–	–	
116	N/A					
117	N/A	–	–	–	–	Fiberglass
118	N/A	–	–	–	–	
155	3.5	200	0	–	3	
	1	200	0	–	1.5	Condensate
178	N/A	–	–	–	–	
179	N/A	–	–	–	–	
358	N/A	–	–	–	–	
360	N/A	–	–	–	–	
400	N/A	–	–	–	–	
522	N/A	–	–	–	–	

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: DUCT AND PIPE INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 17-Apr-92
FILE: MDUCTPIPE.WK3
PREPARED BY: CMD
CHECKED BY: CEL

CHILLED WATER PIPES

BLDG #	PIPE DIA. (IN)	LENGTH (FT)	SURVEY		REQUIRED INS. (IN)
			THICKNESS (IN)	TYPE	
22	1.5	150	0.5	Rubber	0.75
27	N/A	–	–	–	–
28	N/A	–	–	–	–
40	4.5	75	0.5	Rubber	1
	3	39	2	Foam	1
41	N/A	–	–	–	–
42	N/A	–	–	–	–
61	N/A	–	–	–	–
100	N/A	–	–	–	–
101	4	80	1.5	Fiberglass	1
102	N/A	–	–	–	–
105	N/A	–	–	–	–
109	2.5	50	1	Fiberglass	1
111	2	15	0.5	Rubber	0.75
112	N/A	–	–	–	–
114	N/A	–	–	–	–
116	N/A	–	–	–	–
117	2	25	0.5	Rubber	0.75
118	N/A	–	–	–	–
155	N/A	–	–	–	–
178	N/A	–	–	–	–
179	N/A	–	–	–	–
358	3	200	2	Fiberglass	1
	3	10	1.5	Fiberglass	1
	1.25	30	1	Rubber	0.75
360	N/A	–	–	–	–
400	N/A	–	–	–	–
522	1	150	1	Fiberglass	0.5
	1.5	150	1	Fiberglass	0.75

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 1 – Duct Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 10-JUL-92
FILE: ECO-1DM.WK3
PREPARED BY: CMD
CHECKED BY: CEL

DUCTS

BLDG #	DUCT SIZE (in)	PERIMITER LENGTH	DUCT LENGTH (ft)	SURVEY THICKNESS (in)	SURVEY TYPE	REQUIRED INS. (in)
22	24 * 24	96	48	1	Fiberglass	2
27	N/A	–	–	–	–	
28	N/A	–	–	–	–	
40	N/A	–	–	–	–	–
41	24 * 24	96	40	0.75	Fiberglass	2
42	22 * 18	80	69	0	–	2
	12 * 12	48	8	0	–	2
	24 * 24	96	10	0	–	2
61	20 * 20	80	40	3	Fiberglass	2
100	N/A	–	–	–	–	2
101	N/A	–	–	–	–	–
102	20 * 20	80	10	0.5	Fiberglass	2
	12 * 16	56	65	0.75	Fiberglass	2
	10 * 10	40	50	0.75	Fiberglass	2
105	20 * 26	92	4	0	–	2
	20 * 26	92	80	2	Fiberglass	2
109	N/A	–	–	–	–	–
111	N/A	–	–	–	–	–
112	N/A	–	–	–	–	–
114	24 * 24	96	90	1	Fiberglass	2
	9 * 9	36	40	1	Fiberglass	2
116	12 * 14	52	11	0	–	2
	20 * 20	80	90	0	–	2
	11 * 11	44	40	0	–	2
117	N/A	–	–	–	–	2
118	24 * 24	96	90	0.5	Fiberglass	2
155	24 * 24	96	50	1.5	Fiberglass	2
	18 * 18	72	50	1	Fiberglass	2
	30 * 30	120	50	1.5	Fiberglass	2
178	24 * 24	96	10	0.5	Fiberglass	2
	18 * 18	72	10	0.5	Fiberglass	2
	24 * 24	96	10	0.5	Fiberglass	2
	50 * 8	116	65	1.5	Fiberglass	2
	60 * 8	136	65	1.5	Fiberglass	2
179	N/A	–	–	–	–	–
358	36 * 15	102	75	2	Fiberglass	2
	22 * 18	80	35	2	Fiberglass	2
	18 * 38	112	30	2	Fiberglass	2
	36 * 24	120	55	0	–	2
	18 * 80	196	10	0	–	2
360	N/Av	–	–	–	–	2
400	24 * 12	72	225	1	Fiberglass	2
522	N/A	–	–	–	–	–

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: DUCT AND PIPE INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 22-Jul-92
FILE: MDUCTPIPE.WK3
PREPARED BY: CMD
CHECKED BY: CEL

Energy cost:
Gas: $4.67 / MBtu
Electric: 0.0255 /KWH

EXISTING PIPE INSULATION CONDITION

BLDG#	PIPE DIA (in)	PIPE LENGTH (ft)	INSUL. THICK. (in)	k Btuh in/ ft²•°F	FLUID TEMP (°F)	AMB TEMP (°F)	Rc (F/Btuh)	SURFACE TEMP. (F/Btuh)	COND. R (F/Btuh)	CONV. R (F/Btuh)	TOTAL R (F/Btuh)	EXIST TOTAL LOSS (Btuh)	ANNUAL ENERGY LOSS (MBtu/yr)	ANNUAL ENERGY LOSS (KWH/yr)	ANNUAL ENERGY COST ($/yr)
41	3	50	0.5	0.26	140	50	1.59	88.62	2.11	1.59	3.70	1,216	7.10	–	$33.15
	2	50	0.5	0.26	140	50	2.14	87.60	2.98	2.14	5.12	880	5.14	–	$23.99
42	1.5	40	1	0.26	140	50	2.15	73.11	6.22	2.15	8.37	430	2.51	–	$11.72
61	2	100	1	0.26	140	50	1.86	74.05	5.09	1.86	6.95	1,295	7.56	–	$35.32
	3	90	1	0.26	140	50	1.46	75.24	3.75	1.46	5.21	1,553	9.07	–	$42.36
	2	40	1	0.29	255	50	1.46	99.72	4.56	1.46	6.03	1,361	7.95	–	$37.11
	4	50	1.5	0.29	255	50	0.90	90.11	3.69	0.90	4.58	2,237	13.06	–	$61.01
	3	60	1	0.29	255	50	1.15	102.24	3.36	1.15	4.51	2,725	15.91	–	$74.31
	2	10	0	0.29	255	50	–	–	–	–	–	3,220	18.80	–	$87.82
	1	10	0	0.29	255	50	–	–	–	–	–	1,880	10.98	–	$51.27
	2	70	1.5	0.29	255	50	1.30	86.27	6.03	1.30	7.33	1,957	11.43	–	$53.38
	1.5	40	0	0.29	255	50	–	–	–	–	–	10,520	61.44	–	$286.91
	3	40	1	0.29	255	50	1.15	102.24	3.36	1.15	4.51	1,816	10.61	–	$49.54
111	2	15	0	0.26	140	50	–	–	–	–	–	2,280	13.32	–	$62.18
	2	15	0.5	0.26	50	80	2.91	65.18	2.98	2.91	5.88	76	–	19.54	$0.50
109	2.5	50	1	0.26	140	50	1.64	74.73	4.32	1.64	5.95	756	4.41	–	$20.61
112	4	25	0.75	0.29	255	50	0.97	114.98	2.10	0.97	3.07	1,669	9.75	–	$45.52
	3	6	0	0.29	255	50	–	–	–	–	–	2,748	16.05	–	$74.95
	3.5	38	1	0.29	255	50	1.04	103.09	2.98	1.04	4.02	1,939	11.33	–	$52.89
	2	185	1	0.29	255	50	1.46	99.72	4.56	1.46	6.03	6,293	36.75	–	$171.63
	1.5	185	1	0.29	255	50	1.69	97.72	5.58	1.69	7.27	5,214	30.45	–	$142.21
117	2	25	0.5	0.26	50	80	2.91	65.18	2.98	2.91	5.88	127	–	32.56	$0.83
	2	15	0.5	0.26	140	50	2.91	94.45	2.98	2.02	5.00	270	1.58	–	$7.36
	2	4	0	0.29	255	50	–	–	–	–	–	1,288	7.52	–	$35.13
	2	10	1.25	0.26	140	50	1.74	70.38	5.96	1.74	7.70	117	0.68	–	$3.19
155	3.5	200	0	0.29	255	50	–	–	–	–	–	103,600	605.02	–	$2,825.46
	1	200	0	0.26	140	50	–	–	–	–	–	17,800	103.95	–	$485.46
360	2	50	0	0.26	140	50	–	–	–	–	–	7,600	44.38	–	$207.27
522	1.5	150	1	0.26	140	50	2.15	73.11	6.22	2.15	8.37	1,612	9.41	–	$43.96
												TOTALS:	1066.76	52.10	$4,983.08

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: DUCT AND PIPE INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 22-Jul-92
FILE: MDUCTPIPE.WK3
PREPARED BY: CMD
CHECKED BY: CEL

Energy cost:
Gas: $4.67 / MBtu
Electric: 0.0255 /KWH

NEW PIPE INSULATION CONDITION

BLDG#	PIPE DIA (in)	PIPE LENGTH (ft)	INSUL. THICK. (in)	k Btuh in/ ft^2 F	FLUID TEMP. (F)	AMB TEMP (F)	Rc (F/Btuh)	SURFACE TEMP (F/Btuh)	COND. R (F/Btuh)	CONV. R (F/Btuh)	TOTAL R (F/Btuh)	IMPROVED ENERGY LOSS (Btuh)	ANNUAL GAS LOSS (MBtu/yr)	ANNUAL ELECTRIC LOSS (KWH/yr)	ANNUAL ELECTRIC SAVINGS (KWH/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	ENERGY COST ($/yr)	ANNUAL SAVINGS ($/yr)
41	3	50	1.5	0.26	140	50	1.34	68.79	5.09	1.34	6.44	699	4.08	–	0	3.02	19.07	$14.08
	2	50	1.5	0.26	140	50	1.64	67.67	6.73	1.65	8.38	537	3.14	–	0	2.00	14.65	$9.34
42	1.5	40	1.5	0.26	140	50	1.86	66.83	8.07	1.86	9.93	363	2.12	–	0	0.39	9.89	$1.83
61	2	100	1.5	0.26	140	50	1.64	67.67	6.73	1.65	8.38	1,075	6.28	–	0	1.29	29.31	$6.02
	3	90	1.5	0.26	140	50	1.34	68.79	5.09	1.34	6.44	1,259	7.35	–	0	1.72	34.33	$8.03
	2	40	2.5	0.29	255	50	1.07	73.52	8.25	1.07	9.32	880	5.14	–	0	2.81	24.00	$13.11
	4	50	2.5	0.29	255	50	0.80	76.65	5.34	0.80	6.14	1,670	9.75	–	0	3.31	45.54	$15.47
	3	60	2.5	0.29	255	50	0.91	75.38	6.46	0.91	7.37	1,668	9.74	–	0	6.17	45.50	$28.80
	2	10	2.5	0.29	255	50	1.07	73.52	8.25	1.07	9.32	220	1.28	–	0	17.52	6.00	$81.82
	1	10	1.5	0.29	255	50	1.69	82.01	9.13	1.69	10.82	189	1.11	–	0	9.87	5.17	$46.11
	2	70	2.5	0.29	255	50	1.07	73.52	8.25	1.07	9.32	1,540	8.99	–	0	2.44	41.99	$11.38
	1.5	40	1.5	0.29	255	50	1.47	84.52	7.24	1.47	8.70	942	5.50	–	0	55.93	25.70	$261.21
	3	40	2.5	0.29	255	50	0.91	75.38	6.46	0.91	7.37	1,112	6.50	–	0	4.11	30.34	$19.20
111	2	15	1.5	0.26	140	50	1.64	67.67	6.73	1.65	8.38	161	0.94	–	0	12.37	4.40	$57.79
	2	15	1	0.26	50	80	2.49	70.14	5.09	2.49	7.58	59	–	15.16	4	0.00	0.39	$0.11
109	2.5	50	1.5	0.26	140	50	1.48	68.30	5.79	1.48	7.27	619	3.61	–	0	0.80	16.88	$3.73
112	4	25	3	0.29	255	50	0.76	72.83	6.03	0.76	6.79	755	4.41	–	0	5.34	20.58	$24.94
	3	6	2.5	0.29	255	50	0.91	75.38	6.46	0.91	7.37	167	0.97	–	0	15.07	4.55	$70.40
	3.5	38	3	0.29	255	50	0.80	72.29	6.58	0.80	7.38	1,056	6.17	–	0	5.16	28.80	$24.09
	2	185	1.5	0.29	140	50	1.61	68.93	6.03	1.61	7.64	2,179	12.72	–	0	24.03	59.42	$112.21
	1.5	185	2.5	0.29	255	50	1.17	72.21	9.66	1.17	10.83	3,502	20.45	–	0	10.00	95.50	$46.71
117	2	25	1	0.26	50	80	2.49	70.14	5.09	2.49	7.58	99	–	25.27	7	0.00	0.64	$0.19
	2	15	1.5	0.26	140	50	1.64	67.67	6.73	1.65	8.38	161	0.94	–	0	0.64	4.40	$2.97
	2	4	1.5	0.29	140	50	1.61	68.93	6.03	1.61	7.64	47	0.28	–	0	7.25	1.28	$33.84
	2	10	1.5	0.26	140	50	1.64	67.67	6.73	1.65	8.38	107	0.63	–	0	0.06	2.93	$0.26
155	3.5	250	2.5	0.29	255	50	0.85	76.07	5.84	0.85	6.69	7,655	44.71	–	0	560.32	208.78	$2,616.68
	1	250	1.5	0.26	140	50	2.14	65.63	10.18	2.14	12.32	1,826	10.66	–	0	93.29	49.79	$435.67
360	2	50	1.5	0.26	140	50	1.64	67.67	6.73	1.65	8.38	537	3.14	–	0	41.25	14.65	$192.62
522	1.5	150	1.5	0.26	140	50	1.86	66.83	8.07	1.86	9.93	1,360	7.94	–	0	1.47	37.09	$6.88
												TOTALS:	177.47	40.42	11.68	844.90	881.57	$3,945.97

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 1 – Duct Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 10-JUL-92
FILE: ECO-1DM.WK3
PREPARED BY: CMD
CHECKED BY: CEL

EXISTING DUCT INSULATION CONDITION

BLDG. #	DUCT PER. (in)	DUCT LENGTH (ft)	SURFACE AREA (ft^2)	R OUTER FILM	R INNER FILM	R INS.	U	THERMAL COND. (Btu in/ h ft^2 F)	INS. THICK. (in)	LEAK CLASS	STATIC PRESS (in. w.g.)	LEAK RATE (cfm/ 100 ft^2)	TOTAL LEAK (cfm)	WINTER DUCT TEMP (F)	WINTER AMB TEMP (F)	SUMMER DUCT TEMP (F)	SUMMER AMB TEMP (F)	DELTA ENTH
22	96	48	384	0.65	0.220	3.85	0.21	0.26	1	0	0.5	0.0	0.0	90	75	55	90	15.6
41	96	40	320	0.65	0.220	2.88	0.27	0.26	0.75	0	0.5	0.0	0.0	90	75	55	90	15.6
42	80	69	460	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	140.7	90	75	55	90	15.6
	48	8	32	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	9.8	90	75	55	90	15.6
	96	10	80	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	24.5	90	75	55	90	15.6
102	80	10	66.6667	0.65	0.220	1.92	0.36	0.26	0.5	0	0.5	0.0	0.0	90	75	55	90	15.6
	56	65	303.333	0.65	0.220	2.88	0.27	0.26	0.75	0	0.5	0.0	0.0	90	75	55	90	15.6
	40	50	166.667	0.65	0.220	2.88	0.27	0.26	0.75	0	0.5	0.0	0.0	90	75	55	90	15.6
105	92	4	30.6667	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	9.4	90	75	55	90	15.6
114	96	90	720	0.65	0.220	3.85	0.21	0.26	1	0	0.5	0.0	0.0	90	75	55	90	15.6
	36	40	120	0.65	0.220	3.85	0.21	0.26	1	0	0.5	0.0	0.0	90	75	55	90	15.6
116	52	11	47.6667	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	14.6	90	75	55	90	15.6
	80	90	600	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	183.5	90	75	55	90	15.6
	44	40	146.667	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	44.9	90	75	55	90	15.6
118	96	90	720	0.65	0.220	1.92	0.36	0.26	0.5	0	0.5	0.0	0.0	90	75	55	90	15.6
155	96	50	400	0.65	0.220	5.77	0.15	0.26	1.5	0	0.5	0.0	0.0	90	75	55	90	15.6
	72	50	300	0.65	0.220	3.85	0.21	0.26	1	0	0.5	0.0	0.0	90	75	55	90	15.6
	120	10	100	0.65	0.220	5.77	0.15	0.26	1.5	0	0.5	0.0	0.0	90	75	55	90	15.6
358	120	55	550	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	168.2	90	75	55	90	15.6
	196	10	163.333	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	50.0	90	75	55	90	15.6
400	72	225	1350	0.65	0.220	3.85	0.21	0.26	1	0	0.5	0.0	0.0	90	75	55	90	15.6

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 1. DUCT INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 10-JUL-92
FILE: ECO-1DM.WK3
PREPARED BY: CMD
CHECKED BY: CEL

EXISTING DUCT INSULATION CONDITION

BLDG.	ENERGY LOSSES							
	WINTER			SUMMER			ANNUAL	
#	INSUL (Btu/h)	LEAK (Btu/h)	TOTAL (Btu/h)	INSUL (kW)	LEAK (kW)	TOTAL (kW)	GAS (MBtu/yr)	ELECTRIC (kW/yr)
22	1628.4	--	1628.4	0.17	--	0.17	7.1	727.7
41	1704.6	--	1704.6	0.17	--	0.17	7.5	761.7
42	10574.7	3095.7	13670.4	1.08	0.58	1.65	59.9	7247.9
	735.6	215.3	951.0	0.08	0.04	0.12	4.2	504.2
	1839.1	538.4	2377.5	0.19	0.10	0.29	10.4	1260.5
102	477.4	--	477.4	0.05	--	0.05	2.1	213.3
	1615.8	--	1615.8	0.16	--	0.16	7.1	722.0
	887.8	--	887.8	0.09	--	0.09	3.9	396.7
105	705.0	206.4	911.4	0.07	0.04	0.11	4.0	483.2
114	3053.3	--	3053.3	0.31	--	0.31	13.4	1364.4
	508.9	--	508.9	0.05	--	0.05	2.2	227.4
116	1095.8	320.8	1416.6	0.11	0.06	0.17	6.2	751.0
	13793.1	4037.8	17830.9	1.41	0.75	2.16	78.1	9453.8
	3371.6	987.0	4358.7	0.34	0.18	0.53	19.1	2310.9
118	5155.6	--	5155.6	0.53	--	0.53	22.6	2303.9
155	1205.0	--	1205.0	0.12	--	0.12	5.3	538.5
	1272.2	--	1272.2	0.13	--	0.13	5.6	568.5
	301.2	--	301.2	0.03	--	0.03	1.3	134.6
358	12643.7	3701.3	16345.0	1.29	0.69	1.98	71.6	8666.0
	3754.8	1099.2	4854.0	0.38	0.20	0.59	21.3	2573.5
400	5725.0	--	5725.0	0.58	--	0.58	25.1	2558.3

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 1 – Duct Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 10-JUL-92
FILE: ECO-1DM.WK3
PREPARED BY: CMD
CHECKED BY: CEL

EXISTING DUCT INSULATION CONDITION

BLDG. #	DUCT PER. (in)	DUCT LENGTH (ft)	SURFACE AREA (ft²)	R OUTER FILM	R INNER FILM	R INS.	U	THERMAL COND. (Btu in/ h ft² F)	INS. THICK. (in)	LEAK CLASS	STATIC PRESS (in. w.g.)	LEAK RATE (cfm/ 100 ft²)	TOTAL LEAK (cfm)	WINTER DUCT TEMP (F)	WINTER AMB TEMP (F)	SUMMER DUCT TEMP (F)	SUMMER AMB TEMP (F)	SUMMER DELTA ENTH
22	96	48	384	0.65	0.220	3.85	0.21	0.26	1	0	0.5	0.0	0.0	90	75	55	90	15.6
41	96	40	320	0.65	0.220	2.88	0.27	0.26	0.75	0	0.5	0.0	0.0	90	75	55	90	15.6
42	80	69	460	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	140.7	90	75	55	90	15.6
	48	8	32	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	9.8	90	75	55	90	15.6
	96	10	80	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	24.5	90	75	55	90	15.6
102	80	10	66.6667	0.65	0.220	1.92	0.36	0.26	0.5	0	0.5	0.0	0.0	90	75	55	90	15.6
	56	65	303.333	0.65	0.220	2.88	0.27	0.26	0.75	0	0.5	0.0	0.0	90	75	55	90	15.6
	40	50	166.667	0.65	0.220	2.88	0.27	0.26	0.75	0	0.5	0.0	0.0	90	75	55	90	15.6
105	92	4	30.6667	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	9.4	90	75	55	90	15.6
114	96	90	720	0.65	0.220	3.85	0.21	0.26	1	0	0.5	0.0	0.0	90	75	55	90	15.6
	36	40	120	0.65	0.220	3.85	0.21	0.26	1	0	0.5	0.0	0.0	90	75	55	90	15.6
116	52	11	47.6667	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	14.6	90	75	55	90	15.6
	80	90	600	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	183.5	90	75	55	90	15.6
	44	40	146.667	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	44.9	90	75	55	90	15.6
118	96	90	720	0.65	0.220	1.92	0.36	0.26	0.5	0	0.5	0.0	0.0	90	75	55	90	15.6
155	96	50	400	0.65	0.220	5.77	0.15	0.26	1.5	0	0.5	0.0	0.0	90	75	55	90	15.6
	72	50	300	0.65	0.220	3.85	0.21	0.26	1	0	0.5	0.0	0.0	90	75	55	90	15.6
	120	10	100	0.65	0.220	5.77	0.15	0.26	1.5	0	0.5	0.0	0.0	90	75	55	90	15.6
358	120	55	550	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	168.2	90	75	55	90	15.6
	196	10	163.333	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	50.0	90	75	55	90	15.6
400	72	225	1350	0.65	0.220	3.85	0.21	0.26	1	0	0.5	0.0	0.0	90	75	55	90	15.6

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 1. DUCT INSULATION

EMC PROJECT: #3105.000
DATE: 10-JUL-92
FILE: ECO-1DM.WK3
PREPARED BY: CMD
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXISTING DUCT INSULATION CONDITION

BLDG.	ENERGY LOSSES							
	WINTER			SUMMER			ANNUAL	
#	INSUL (Btu/h)	LEAK (Btu/h)	TOTAL (Btu/h)	INSUL (kW)	LEAK (kW)	TOTAL (kW)	GAS (MBtu/yr)	ELECTRIC (kW/yr)
22	1628.4	--	1628.4	0.17	--	0.17	7.1	727.7
41	1704.6	--	1704.6	0.17	--	0.17	7.5	761.7
42	10574.7	3095.7	13670.4	1.08	0.58	1.65	59.9	7247.9
	735.6	215.3	951.0	0.08	0.04	0.12	4.2	504.2
	1839.1	538.4	2377.5	0.19	0.10	0.29	10.4	1260.5
102	477.4	--	477.4	0.05	--	0.05	2.1	213.3
	1615.8	--	1615.8	0.16	--	0.16	7.1	722.0
	887.8	--	887.8	0.09	--	0.09	3.9	396.7
105	705.0	206.4	911.4	0.07	0.04	0.11	4.0	483.2
114	3053.3	--	3053.3	0.31	--	0.31	13.4	1364.4
	508.9	--	508.9	0.05	--	0.05	2.2	227.4
116	1095.8	320.8	1416.6	0.11	0.06	0.17	6.2	751.0
	13793.1	4037.8	17830.9	1.41	0.75	2.16	78.1	9453.8
	3371.6	987.0	4358.7	0.34	0.18	0.53	19.1	2310.9
118	5155.6	--	5155.6	0.53	--	0.53	22.6	2303.9
155	1205.0	--	1205.0	0.12	--	0.12	5.3	538.5
	1272.2	--	1272.2	0.13	--	0.13	5.6	568.5
	301.2	--	301.2	0.03	--	0.03	1.3	134.6
358	12643.7	3701.3	16345.0	1.29	0.69	1.98	71.6	8666.0
	3754.8	1099.2	4854.0	0.38	0.20	0.59	21.3	2573.5
400	5725.0	--	5725.0	0.58	--	0.58	25.1	2558.3

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

[X] CODE A [ ] CODE B [ ] CODE C [ ] OTHER ______

EFFECTIVE PRICING DATE APR 92

DATE PREPARED 22-Apr-92

DRAWING NO.

SHT OF

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

ESTIMATOR RMG

CHECKED BY CEL

PIPE INSULATION	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
'1.5" INSULATION, FITS 2" PIPE	1	LF	0.084	0.084	$20.88	$1.75			$2.82	$2.82	$4.57		
'2" INSULATION, FITS 1" PIPE	1	LF	0.08	0.08	$20.88	$1.67			$3.59	$3.59	$5.26		
'1.5" INSULATION, FITS 3" PIPE	1	LF	0.094	0.094	$20.88	$1.96			$3.20	$3.20	$5.16		
'1.5" INSULATION, FITS 1.5" PIPE	1	LF	0.08	0.08	$20.88	$1.67			$2.60	$2.60	$4.27		
'1.5" INSULATION, FITS 4" PIPE	1	LF	0.114	0.114	$20.88	$2.38			$3.65	$3.65	$6.03		
'2.5" INSULATION, FITS 2" PIPE	1	LF	0.093	0.093	$20.88	$1.94			$3.19	$3.19	$5.13		
'2.5" INSULATION, FITS 4" PIPE	1	LF	0.133	0.133	$20.88	$2.78			$4.36	$4.36	$7.14		
2.5" INSULATION, FITS 3" PIPE	1	LF	0.106	0.106	$20.88	$2.21			$3.91	$3.91	$6.12		
1.5" INSULATION, FITS 1" PIPE	1	LF	0.076	0.076	$20.88	$1.59			$2.29	$2.29	$3.88		
1" INSULATION, FITS 2" PIPE	1	LF	0.08	0.08	$20.88	$1.67			$1.58	$1.58	$3.25		
3" INSULATION, FITS 4" PIPE	1	LF	0.144	0.144	$20.88	$3.01			$5.55	$5.55	$8.56		
3" INSULATION, FITS 3.5" PIPE	1	LF	0.121	0.121	$20.88	$2.53			$4.71	$4.71	$7.24		
2.5" INSULATION, 1.5" PIPE	1	LF	0.088	0.088	$20.88	$1.84			$3.19	$3.19	$5.03		
SUBTOTAL						$27.00				$44.64	$71.64		
OVERHEAD, BOND	15%					$4.05				$6.70	$10.75		
PROFIT	10%					$2.70				$4.46	$7.16		
COST SUB-TOTAL						$33.75				$55.80	$89.55		
CONTINGENCY	15%					$5.06				$8.37	$13.43		
TOTAL						$38.81				$64.17	$102.98		

DA FORM 5418-R, APR 85

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study LOCATION Ft. McPherson & Ft Gillem	INVITATION NO./CONTRACT NO. DACA 21-91-C-0097 X CODE A / CODE B / CODE C OTHER	EFFECTIVE PRICING DATE APR 92 DRAWING NO. ESTIMATOR RMG	DATE PREPARED 14-Jul-92 SHT OF CHECKED BY CEL

DUCT INSULATION	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
INSULATE DUCTS													
FLEXIBLE BLANKET TYPE	1	SF	0.058	0.058	$20.88	$1.21			$0.90	$0.90	$2.11		
FIBERGLASS INSULATION (2")													
JOINT SEALING													
SUBTOTAL				$0.06		$1.21				$0.90	$2.11		
OVERHEAD, BOND	15%			$0.01		$0.18				$0.14	$0.32		
PROFIT	10%			$0.01		$0.12				$0.09	$0.21		
COST SUB-TOTAL				$0.07		$1.51				$1.13	$2.64		
CONTINGENCY	15%			$0.01		$0.23				$0.17	$0.40		
TOTAL				$0.08		$1.74				$1.29	$3.03		

ECO-7, CONTROL HOT WATER CIRCULATION PUMPS

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: MECO15
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-7A HOT WATER PUMP
ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	19736.
B. SIOH	$	1086.
C. DESIGN COST	$	1185.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	22007.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	325.	$ 2430.	11.11	26994.
B. DIST	$ .00	0.	$ 0.	14.26	0.
C. RESID	$ .00	0.	$ 0.	16.89	0.
D. NAT G	$ 4.67	498.	$ 2326.	14.45	33606.
E. COAL	$ .00	0.	$ 0.	11.21	0.
F. TOTAL		823.	$ 4755.		$ 60600.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 10.59
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 19998.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 4755.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 60600.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 2.75
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 4.63

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 7 – Hot Water Pumps

CLIENT CONTRACT NO: DACA21–91–C–0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15–Jul–92
FILE: ECO–7.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	14.45 UPWG
Electric Savings	$0.0255 / kWh	11.11 UPWE
Demand Savings	$8.85 / kW	10.59 UPW

Economic Life: 15 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON–ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
170	0	47,639	249	411	$2,378	$0	$0	$2,378	$11,003	2.8	4.6
171	0	47,639	249	411	$2,378	$0	$0	$2,378	$11,003	2.8	4.6
TOTAL	0	95,278	498	823	$4,755	$0	$0	$4,755	$22,006	2.8	4.6

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study LOCATION Ft. McPherson & Ft Gillem	INVITATION NO./CONTRACT NO. DACA 59-90-C-0087 ☐ CODE A ☒ CODE B ☐ CODE C ☐ OTHER ______	EFFECTIVE PRICING DATE APR. 91 DRAWING NO. ESTIMATOR CEL	DATE PREPARED 22-Apr-92 SHT OF CHECKED BY CEL

HW PUMP CONTROL	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
WTS	2	EA	5.0	10.0	21.17	$211.70			261.0	522.00	734		
STS	1	EA	1.5	1.5	21.17	$31.76			118	118.00	150		
VALVE	1	EA	2.0	2.0	21.17	$42.34			370	370.00	412		
ST/SP	1	EA	2.0	2.0	21.17	$42.34			66	66.00	108		
PUMP DPS	1	EA	2.5	2.5	21.17	$52.93			129	129.00	182		
WIRE AND CONDUIT	6								$94.00	$564.00	$564.00		
PROGRAMMING	6					$900.00					$900.00		
SUBTOTAL						$1,281				$1,769	$3,050		
OVERHEAD, BOND	15%					$192				$265	$458		
PROFIT	10%					$128				$177	$305		
COST SUB-TOTAL						$1,601				$2,211	$3,813		
CONTINGENCY	15%					$240				$332	$572		
CONTROLLER										$1,100	$1,100		
TOTAL THIS SHEET						$1,842				$3,643	$5,484		

DA FORM 5418-R, APR 85

ECO-11, REPLACE STREET LIGHTS

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: MECO25
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-11 REPLACE STREET LIGHTS
ANALYSIS DATE: 09-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	6204.
B. SIOH	$	342.
C. DESIGN COST	$	373.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	6919.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	148.	$ 1106.	15.61	17260.
B. DIST	$ .00	0.	$ 0.	21.66	0.
C. RESID	$ .00	0.	$ 0.	26.51	0.
D. NAT G	$ 4.67	0.	$ 0.	23.77	0.
E. COAL	$ .00	0.	$ 0.	16.06	0.
F. TOTAL		148.	$ 1106.		$ 17260.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 417.
(1) DISCOUNT FACTOR (TABLE A) 14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 6063.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 6063.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 5696.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) 3.32
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 1523.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 23323.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 3.37
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 4.54

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO–11: REPLACE EXTERIOR LIGHTING

CLIENT CONTRACT NO: DACA21–91–C–0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 09/01/92
FILE: EXT_LITES.WK3
PRPARED BY: JIM WATTERS
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
INCREMENTAL GAS COST	$4.67 MBtu	23.77 UPWG
INCREMENTAL ELECTRIC COST	$0.0256 kWh	15.61 UPWE
ELECTRIC DEMAND CHARGE	$102.66 kW	14.53 UPW
ECONOMIC LIFE	25 YRS	

ESTIMATED 3285 HOURS OF EXTERIOR LIGHTING PER YEAR

Existing Bulb Wattage (WATTS)	Existing Bulb Type	Number of Bulbs	Replacement Bulb Wattage (WATTS)	Replacement Bulb Type	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWH)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND SAVINGS ($)	ANNUAL NON–ENI SAVINGS ($)	TOTAL ANNUAL SAVINGS ($)	CONST. COST ($)	SIR	SIMPLE PAYBACK (YRS)
1500	QUARTS	12	400	HPS*	0	43,362	0	148	$1,110	$0	$417	$1,527	$6,917	3.4	4.5
TOTAL		12	400	HPS*	0	43,362	0	148	$1,110	$0	$417	$1,527	$6,917	3.4	4.5

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO.	DACA 21-91-C-0097
EFFECTIVE PRICING DATE	APR 92
DATE PREPARED	22-Apr-92
PROJECT	Ft. McPherson & Ft. Gillem ESOS Study
LOCATION	Ft. McPherson & Ft Gillem
X CODE A / CODE B / CODE C / OTHER	
DRAWING NO.	
SHT OF	
ESTIMATOR	RMG
CHECKED BY	CEL

EXTERIOR LIGHTING	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
400 W HPS LAMP w/ FIXTURE	1	EA	4	4	$21.17	$84.68			$275.00	$275.00	$359.68		
OVERHEAD, BOND	15%					$12.70				$41.25	$53.95		
PROFIT	10%					$8.47				$27.50	$35.97		
COST SUB-TOTAL						$105.85				$343.75	$449.60		
CONTINGENCY	15%					$15.88				$51.56	$67.44		
TOTAL						$121.73				$395.31	$517.04		
200 W HPS LAMP w/ FIXTURE	1	EA	4	4	$21.17	$84.68			$250.00	$250.00	$334.68		
OVERHEAD, BOND	15%					$12.70				$37.50	$50.20		
PROFIT	10%					$8.47				$25.00	$33.47		
COST SUB-TOTAL						$105.85				$312.50	$418.35		
CONTINGENCY	15%					$15.88				$46.88	$62.75		
TOTAL						$121.73				$359.38	$481.10		
360 W HPS LAMP	1	EA	1	1	$21.17	$21.17			35	$35.00	$56.17		
OVERHEAD, BOND	15%					$3.18				$5.25	$8.43		
PROFIT	10%					$2.12				$3.50	$5.62		
COST SUB-TOTAL						$26.46				$43.75	$70.21		
CONTINGENCY	15%					$3.97				$6.56	$10.53		
TOTAL						$30.43				$50.31	$80.74		
150 W HPS LAMP	1	EA	1	1	$21.17	$21.17			25	$25.00	$46.17		
OVERHEAD, BOND	15%					$3.18				$3.75	$6.93		
PROFIT	10%					$2.12				$2.50	$4.62		
COST SUB-TOTAL						$26.46				$31.25	$57.71		
CONTINGENCY	15%					$3.97				$4.69	$8.66		
TOTAL						$30.43				$35.94	$66.37		

DA FORM 5418-R, APR 85

ECO-12, REVISE OR REPAIR HVAC CONTROLS

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: MECO15
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-12A HVAC CONTROLS
ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	204127.
B. SIOH	$	11227.
C. DESIGN COST	$	12248.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	227602.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	4118.	$ 30770.	11.11	341853.
B. DIST	$ .00	0.	$ 0.	14.26	0.
C. RESID	$ .00	0.	$ 0.	16.89	0.
D. NAT G	$ 4.67	973.	$ 4544.	14.45	65660.
E. COAL	$ .00	0.	$ 0.	11.21	0.
F. TOTAL		5091.	$ 35314.		$ 407512.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 10111.
(1) DISCOUNT FACTOR (TABLE A) 10.59
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 107075.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 107075.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 134479.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 45425.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 514588.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 2.26
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 5.01

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 12 – HVAC Controls

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-Jul-92
FILE: ECO-12.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	14.45 UPWG
Electric Savings	$0.0255 / kWh	11.11 UPWE
Demand Savings	$8.85 / kW	10.59 UPW

Economic Life: 15 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON-ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
171	26	193,390	262	921	$6,155	$2,669	$127	$8,951	$24,886	4.1	2.8
170	23	171,230	232	816	$5,450	$2,363	$127	$7,940	$28,402	3.2	3.6
131	22	160,374	217	764	$5,104	$2,213	$127	$7,445	$31,919	2.7	4.3
181	0	249,984	202	1,054	$7,318	$0	$127	$7,445	$41,867	2.0	5.6
246	0	181,411	42	661	$4,822	$0	$127	$4,949	$27,815	2.0	5.6
101	8	113,894	0.29	389	$2,906	$822	$127	$3,855	$24,599	1.7	6.4
514	5	65,286	17	240	$1,744	$513	$127	$2,384	$23,514	1.1	9.9
100	5	71,096	0.18	243	$1,814	$513	$127	$2,454	$24,599	1.1	10.0
TOTAL	89	1,206,665	973	5,087	$35,313	$9,095	$1,016	$45,423	$227,602	2.3	5.0

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 12 – HVAC Controls

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

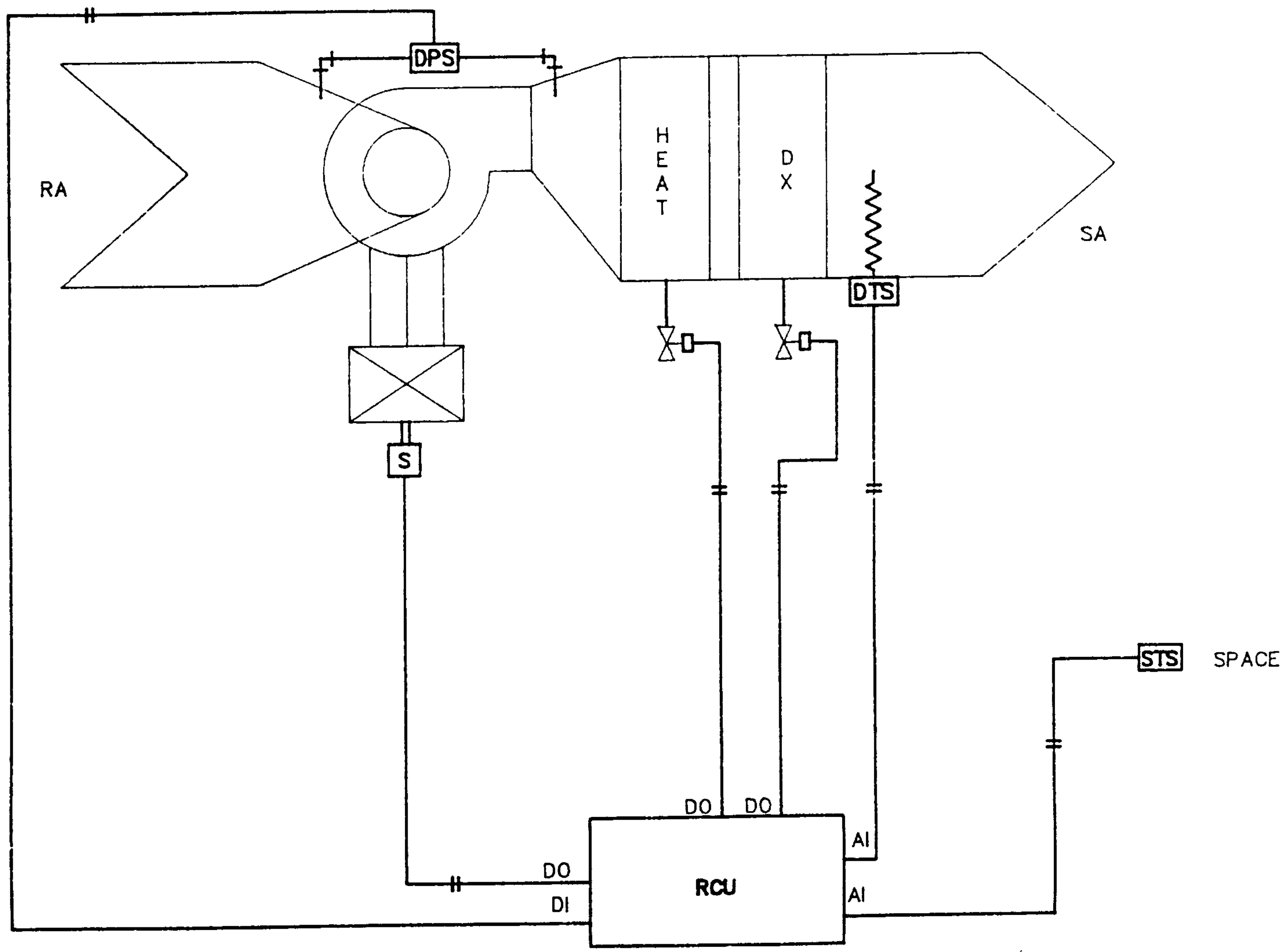
EMC PROJECT: #3105.000
DATE:
FILE: ECO-12.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG #	EQUIPMENT	#	UNIT COST ($/ea)	SUB-TOTAL ($)	TOTAL COST ($)
060				$55,560	$61,950
	DDC Panel	1	$8,050.00		
	FCU	12	$3,154.00		
	Chiller	0.25	$3,577.00		
	Conv	2	$4,384.00		
056,058,				$42,944	$47,883
062	DDC Panel	1	$8,050.00		
	FCU	8	$3,154.00		
	Chiller	0.25	$3,577.00		
	Conv	2	$4,384.00		
100,101				$22,062	$24,599
	DDC Panel	1	$8,050.00		
	AHU	2	$3,154.00		
	Chiller	1	$3,577.00		
	Boiler	1	$4,127.00		
131				$28,627	$31,919
	DDC Panel	1	$8,050.00		
	AHU	4	$3,154.00		
	Chiller	1	$3,577.00		
	Conv	1	$4,384.00		
168				$22,319	$24,886
	DDC Panel	1	$8,050.00		
	FCU	2	$3,154.00		
	Chiller	1	$3,577.00		
	Conv	1	$4,384.00		
170				$25,473	$28,402
	DDC Panel	1	$8,050.00		
	AHU	3	$3,154.00		
	Chiller	1	$3,577.00		
	Conv	1	$4,384.00		
171				$22,319	$24,886
	DDC Panel	1	$8,050.00		
	AHU	2	$3,154.00		
	Chiller	1	$3,577.00		
	Conv	1	$4,384.00		
181				$37,549	$41,867
	DDC Panel	1	$8,050.00		
	MZ AHU	2	$9,192.00		
	FCU	1	$3,154.00		
	Chiller	1	$3,577.00		
	Conv	1	$4,384.00		
184				$47,294	$52,733
	DDC Panel	1	$8,050.00		
	AHU	10	$3,154.00		
	Chiller	1	$3,577.00		
	Boiler	1	$4,127.00		
246				$24,946	$27,815
	DDC Panel	1	$8,050.00		
	MZ AHU	1	$9,192.00		
	Chiller	1	$3,577.00		
	Boiler	1	$4,127.00		
358				$34,678	$38,666
	DDC Panel	1	$8,050.00		
	AHU	6	$3,154.00		
	Chiller	1	$3,577.00		
	Boiler	1	$4,127.00		
500				$40,986	$45,699
	DDC Panel	1	$8,050.00		
	AHU	8	$3,154.00		
	Chiller	1	$3,577.00		
	Boiler	1	$4,127.00		
514				$21,089	$23,514
	DDC Panel	1	$8,050.00		
	AHU	3	$3,154.00		
	Chiller	1	$3,577.00		

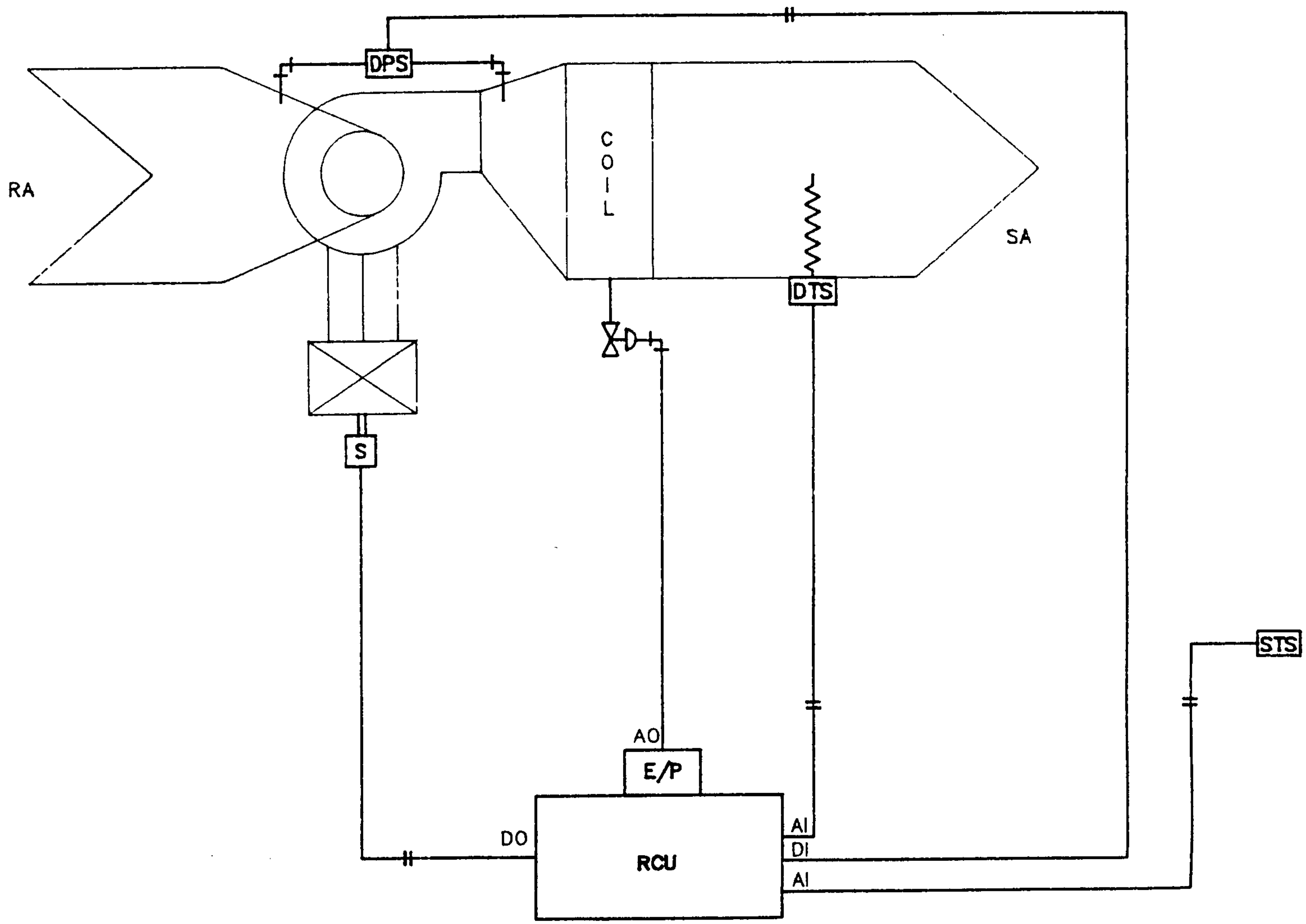
EQUIPMENT COSTS:

DDC Panel	$8,050
FCU	$3,154
AHU	$3,154
MZ AHU	$9,192
Chiller	$3,577
Conv	$4,384
Boiler	$4,127

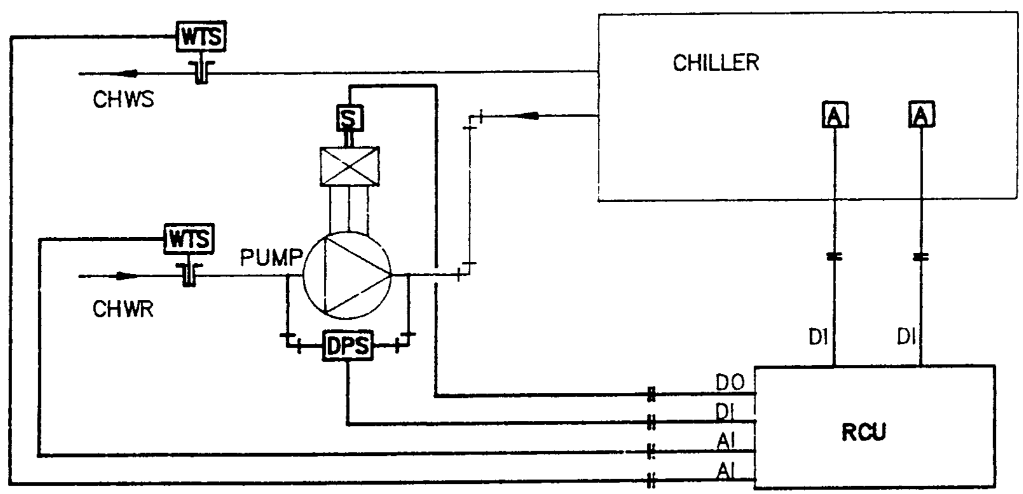
(SUB-TOTAL) + (SUB-TOTAL * .055 SIOH) + (SUB-TOTAL * .06 DESIGN) = TOTAL COST



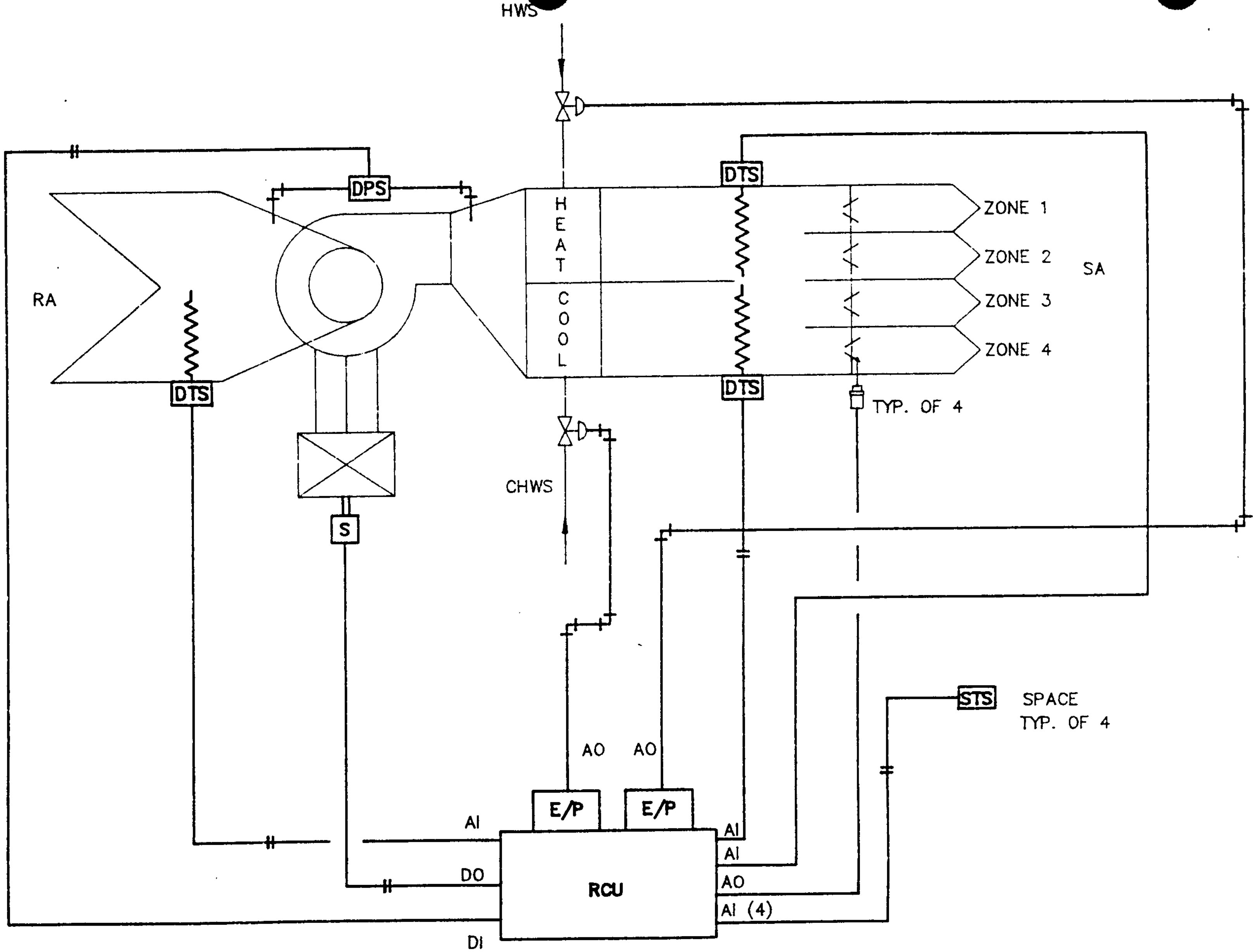
TYPICAL SINGLE ZONE AHU



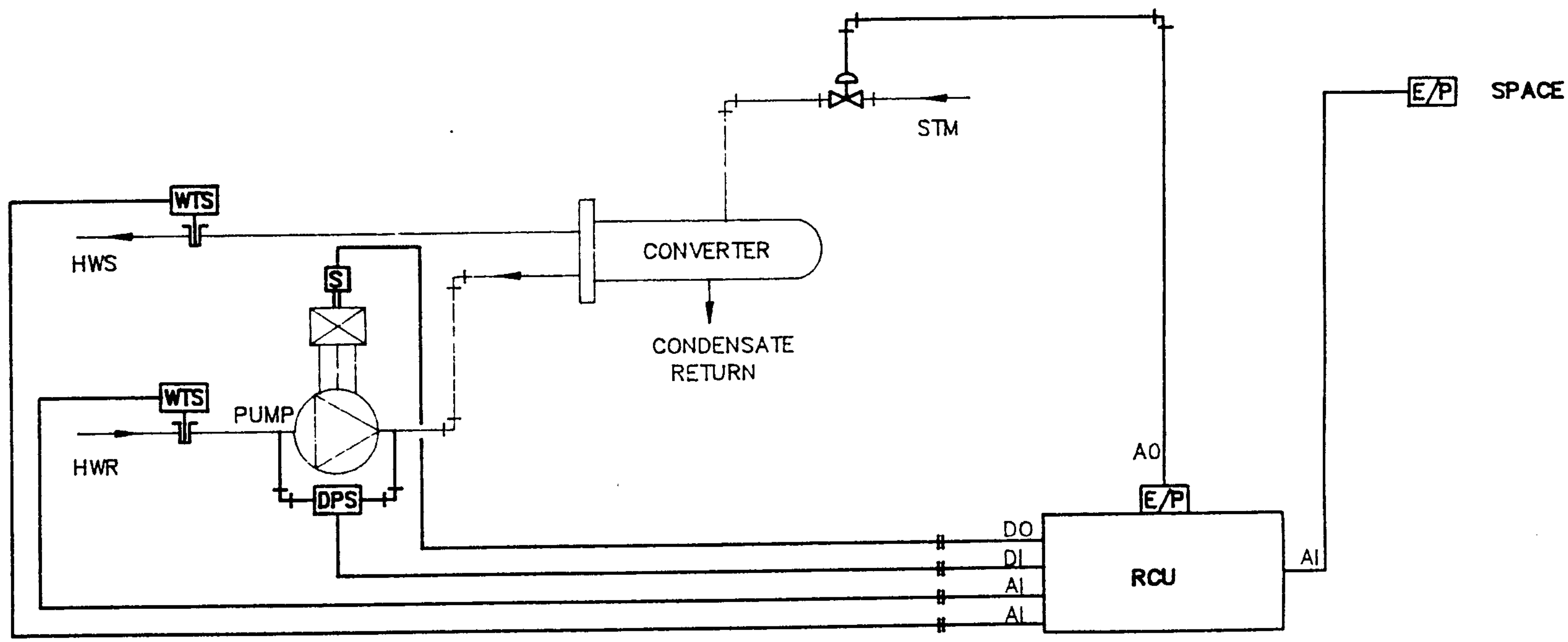
TYPICAL AHU
BLDGS. 184, 60, 56, 58, 62, 100, 101, 358, 500 & 514



TYPICAL AIR COOLED CHILLER
BLDGS. 184, 181, 246, 60, 168, 171, 170, 358 & 500

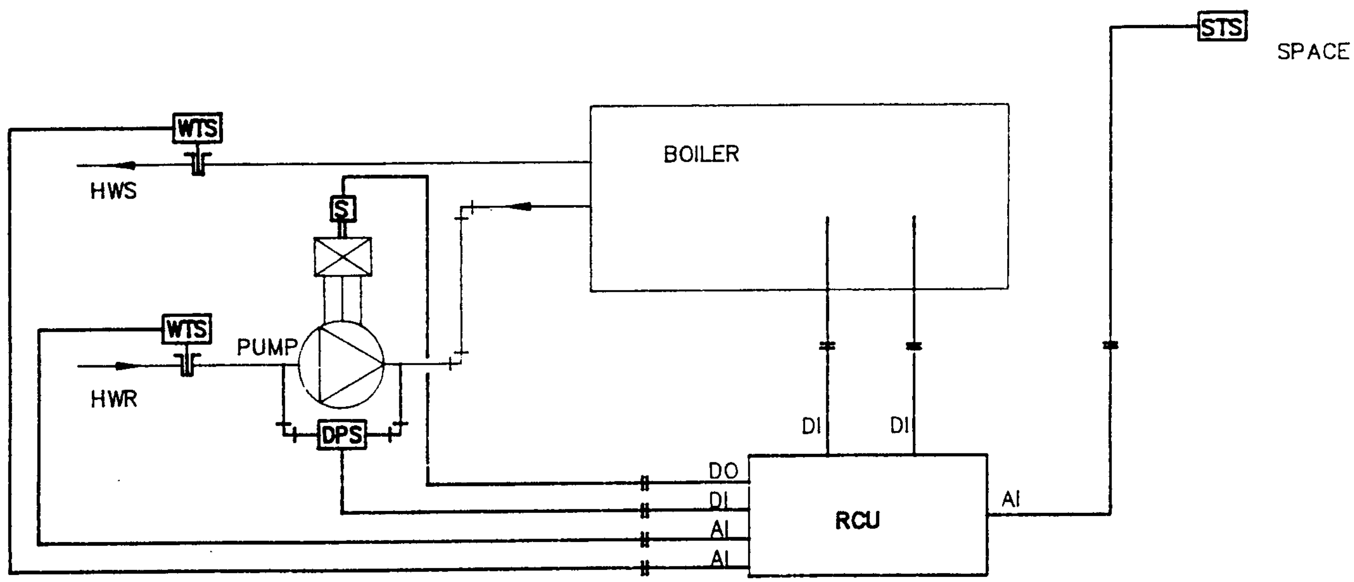


TYPICAL MULTIZONE AHU
BLDGS. 181 & 246

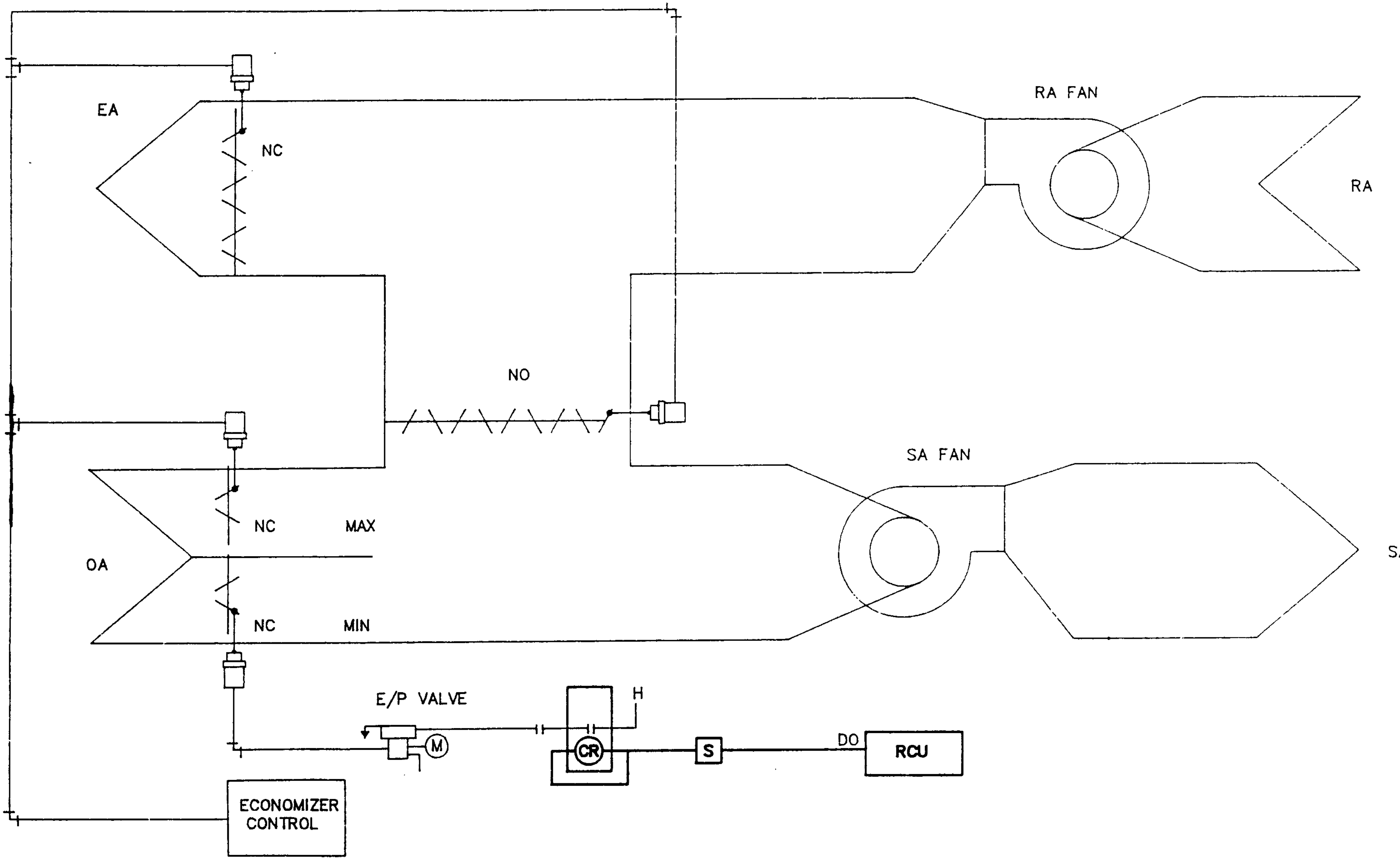


TYPICAL STM/HW CONVERTER

BLDGS. 181, 60, 168, 171, 170, 131, & 61



TYPICAL HW BOILER
BLDGS. 184 & 246



VAV – BUILDING 200

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

INVITATION NO./CONTRACT NO.
DACA 21-91-C-0097

[X] CODE A [ ] CODE B [ ] CODE C
[ ] OTHER ______

EFFECTIVE PRICING
DATE APR. 92

DRAWING NO.

ESTIMATOR RMG

DATE PREPARED
16-Apr-92

SHT OF

CHECKED BY CEL

CONVERTER	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
WTS	2	EA	5.0	10.0	21.17	$211.70			261.0	522.00	734		
STS	1	EA	1.5	1.5	21.17	$31.76			118	118.00	150		
VALVE	1	EA	2.0	2.0	21.17	$42.34			370	370.00	412		
ST/SP	1	EA	2.0	2.0	21.17	$42.34			66	66.00	108		
PUMP DPS	1	EA	2.5	2.5	21.17	$52.93			129	129.00	182		
WIRE AND CONDUIT	6								$94.00	$564.00	$564.00		
PROGRAMMING	6					$900.00					$900.00		
SUBTOTAL						$1,281				$1,769	$3,050		
CONTINGENCY	15%					$192				$265	$458		
COST SUB-TOTAL						$1,473				$2,034	$3,508		
OVERHEAD, BOND	15%					$221				$305	$526		
PROFIT	10%					$147				$203	$351		
SUBTOTAL						$1,842				$2,543	$4,384		
TOTAL THIS SHEET						$1,842				$2,543	$4,384		

DA FORM 5418-R, APR 85

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

X CODE A | CODE B | CODE C | OTHER

EFFECTIVE PRICING DATE April 92

DATE PREPARED 16-Apr-92

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

DRAWING NO.

SHT OF

ESTIMATOR RMG

CHECKED BY CEL

AHU	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
STS	1	EA	1.5	1.5	21.17	$31.76			$118.00	$118.00	$149.76		
DTS	1	EA	2	2.0	21.17	$42.34			$160.00	$160.00	$202.34		
VALVE	1	EA	2.0	2.0	21.17	$42.34			$370.00	$370.00	$412.34		
ST/SP	1	EA	2.0	2.0	21.17	$42.34			$66.00	$66.00	$108.34		
FAN DPS	1	EA	2.0	2.0	21.17	$42.34			$59.00	$59.00	$101.34		
WIRE AND CONDUIT	5								$94.00	$470.00	$470.00		
PROGRAMMING	5					$750.00					$750.00		
SUBTOTAL						$951				$1,243	$2,194		
CONTINGENCY	15%					$143				$186	$329		
COST SUB-TOTAL						$1,094				$1,429	$2,523		
OVERHEAD, BOND	15%					$164				$214	$378		
PROFIT	10%					$109				$143	$252		
SUBTOTAL						$1,367				$1,787	$3,154		
TOTAL THIS SHEET						$1,367				$1,787	$3,154		

DA FORM 5418 85

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

X CODE A ☐ CODE B ☐ CODE C ☐ OTHER

EFFECTIVE PRICING DATE APR. 92

DRAWING NO.

ESTIMATOR RMG

DATE PREPARED 16-Apr-92

SHT OF

CHECKED BY CEL

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

MZ AHU	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
STS	4	EA	1.5	6.0	21.17	85			118	472.00	557		
DTS	3	EA	2.0	6.0	21.17	64			160	480.00	544		
VALVE	2	EA	2.0	4.0	21.17	42			370	740.00	782		
DAMPER	4	EA	1.3	5.2	21.17	85			150	600.00	685		
ST/SP	1	EA	2.0	2.0	21.17	21			66	66.00	87		
FAN DPS	1	EA	2	2.0	21.17	21			59	59.00	80		
WIRE AND CONDUIT	15								$94.00	$1,410.00	$1,410.00		
PROGRAMMING	15					$2,250.00					$2,250.00		
SUBTOTAL						$2,568				$3,827	$6,395		
CONTINGENCY	15%					$385				$574	$959		
COST SUB-TOTAL						$2,953				$4,401	$7,354		
OVERHEAD, BOND	15%					$443				$660	$1,103		
PROFIT	10%					$295				$440	$735		
SUBTOTAL						$3,691				$5,501	$9,192		
TOTAL THIS SHEET						$3,691				$5,501	$9,192		

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

EFFECTIVE PRICING DATE APR. 92

DATE PREPARED 16-Apr-92

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

X CODE A CODE B CODE C OTHER

DRAWING NO.

SHT OF

ESTIMATOR RMG

CHECKED BY CEL

CHILLER	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
WTS	2	EA	5.0	10.0	21.17	42			261	522.00	564		
ST/SP	1	EA	2.0	2.0	21.17	21			66	66.00	87		
PUMP DPS	1	EA	2.5	2.5	21.17	21			129	129.00	150		
STATUS RELAY	2	EA	1.0	2.0	21.17	42			90	180.00	222		
WIRE AND CONDUIT	6								$94.00	$564.00	$564.00		
PROGRAMMING	6					$900.00					$900.00		
SUBTOTAL						$1,027				$1,461	$2,488		
CONTINGENCY	15%					$154				$219	$373		
COST SUB-TOTAL						$1,181				$1,680	$2,861		
OVERHEAD, BOND	15%					$177				$252	$429		
PROFIT	10%					$118				$168	$286		
SUBTOTAL						$1,476				$2,100	$3,577		
TOTAL THIS SHEET						$1,476				$2,100	$3,577		

DA FORM 5418-R, APR 85

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

X CODE A | CODE B | CODE C | OTHER

EFFECTIVE PRICING DATE APR. 92

DRAWING NO.

ESTIMATOR RMG

DATE PREPARED 16-Apr-92

SHT OF

CHECKED BY CEL

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

BOILER	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
WTS	2	EA	5.0	10.0	21.17	42			261	522.00	564		
STS	1	EA	1.5	1.5	21.17	21			118	118.00	139		
ST/SP	1	EA	2.0	2.0	21.17	21			66	66.00	87		
PUMP DPS	1	EA	2.5	2.5	21.17	21			129	129.00	150		
STATUS RELAY	2	EA	1.0	2.0	21.17	42			90	180.00	222		
WIRE AND CONDUIT	7								$94.00	$658.00	$658.00		
PROGRAMMING	7					$1,050.00					$1,050.00		
SUBTOTAL						$1,198				$1,673	$2,871		
CONTINGENCY	15%					$180				$251	$431		
COST SUB-TOTAL						$1,378				$1,924	$3,302		
OVERHEAD, BOND	15%					$207				$289	$495		
PROFIT	10%					$138				$192	$330		
SUBTOTAL						$1,722				$2,405	$4,127		
TOTAL THIS SHEET						$1,722				$2,405	$4,127		

DA FORM 5418-R, APR 85

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

EFFECTIVE PRICING DATE APR. 92

DATE PREPARED 16-Apr-92

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

[X] CODE A [ ] CODE B [ ] CODE C [ ] OTHER

DRAWING NO.

SHT OF

ESTIMATOR RMG

CHECKED BY CEL

DDC PANNEL	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
PER BUILDING INCLUDING LABOR, POWER	1								5,600	5600.00	5,600		
CONNECTION, ENCLOSURE													
SUBTOTAL										$5,600	$5,600		
CONTINGENCY	15%									$840	$840		
COST SUB-TOTAL										$6,440	$6,440		
OVERHEAD, BOND	15%									$966	$966		
PROFIT	10%									$644	$644		
SUBTOTAL										$8,050	$8,050		
TOTAL THIS SHEET										$8,050	$8,050		

DA FORM 5418-R, APR 85

ECO-15, LIGHTING CONTROLS IN BUILDING 200

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: MECO25

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.062

INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3

PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY

FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-15 BLDG. 200 LIGHTING CONTRO

ANALYSIS DATE: 07-16-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	127770.
B. SIOH	$	7028.
C. DESIGN COST	$	7667.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	142465.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	2599.	$ 19418.	15.61	303118.
B. DIST	$ .00	0.	$ 0.	21.66	0.
C. RESID	$ .00	0.	$ 0.	26.51	0.
D. NAT G	$ 4.67	0.	$ 0.	23.77	0.
E. COAL	$ .00	0.	$ 0.	16.06	0.
F. TOTAL		2599.	$ 19418.		$ 303118.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) — $ 16734.
  (1) DISCOUNT FACTOR (TABLE A) — 14.53
  (2) DISCOUNTED SAVING/COST (3A X 3A1) — $ 243145.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 243145.

D. PROJECT NON ENERGY QUALIFICATION TEST
  (1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 100029.
    A IF 3D1 IS = OR > 3C GO TO ITEM 4
    B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) 2.83
    C IF 3D1B IS = > 1 GO TO ITEM 4
    D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 36152.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 546263.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 3.83
   (IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 3.94

E M C ENGINEERS, INC.
PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT MCPHERSON
ECO: AUTOMATIC LIGHTING CONTROL IN BLDG-200

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 07/16/92
FILE: LITE200.WK3
PRPARED BY: DENNIS JONES
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
INCREMENTAL GAS COST	$4.67 MBtu	23.77 UPWG
INCREMENTAL ELECTRIC COST	$0.0255 kWh	15.61 UPWE
ELECTRIC DEMAND CHARGE	$102.66 kW	14.53 UPW
ECONOMIC LIFE	25 YRS	

BUILDING NUMBER	FLOOR AREA (ft2)	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWH)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND SAVINGS ($)	ANNUAL NON-ENE SAVINGS ($)	TOTAL ANNUAL SAVINGS ($)	CONST. COST ($)	SIR	SIMPLE PAYBACK (YRS)
200	274,244	163	761,510	0	2,599	19,419	16,734	0	36,152	142,464	3.8	3.9

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study	INVITATION NO./CONTRACT NO. DACA 21-91-C-0097	EFFECTIVE PRICING DATE APR 92	DATE PREPARED 15-Jul-92
LOCATION Ft. McPherson & Ft Gillem	X CODE A ☐ CODE B ☐ CODE C ☐ OTHER ______	DRAWING NO.	SHT OF
		ESTIMATOR RMG	CHECKED BY CEL

INDIVIDUAL OFFICES: SINGLE LEVEL LIGHTING CONTROL FROM OCCUPANCY SENSORS	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
#W 1000A-ULTRASONIC SENSOR	150	EA	3.31	496.5	$21.17	$10,510.91			$85.00	$12,750.00	$23,260.91		
POWER PACK #A277D	150	EA	0.95	142.5	$21.17	$3,016.73			$25.00	$3,750.00	$6,766.73		
REMOVE WALL SWITCH/WIRING	150	EA	0.95	142.5	$21.17	$3,016.73			$8.00	$1,200.00	$4,216.73		
SENSOR WIRING/CONNECTIONS	150	EA	0.48	72	$21.17	$1,524.24			$20.00	$3,000.00	$4,524.24		
ADD LV RELAY FOR REMOTE	–	–	DELETE OCCUPANCY										
TELEPHONE LTG CONTROL			SENSORS ONLY FOR OFFICES										
OPEN OFFICE AREAS													
PHONE OVERRIDE MODULE	12	EA	7.1	85.2	$21.17	$1,804			$900.00	$10,800	$12,604		
PROGRAMMABLE SYSTEM SWITCH	1	EA	23.4	23.4	$21.17	$495			$1,000.00	$1,000	$1,495		
LIGHTING AUTOMATION PANEL	12	EA	47.3	567.6	$21.17	$12,016			$2,000.00	$24,000	$36,016		
SYSTEM CONNECTION	1	LS							$1,500.00	$1,500	$1,500		
(EST. 1 PER SECMENT)													
PROGRAMMING	144	PNT			$150.00	$21,600.00					$21,600.00		
SUBTOTAL						$32,384				$56,500	$88,884		
OVERHEAD, BOND	15%					$4,858				$8,475	$13,333		
PROFIT	10%					$3,238				$5,650	$8,888		
COST SUB-TOTAL						$40,480				$70,625	$111,105		
CONTINGENCY	15%					$6,072				$10,594	$16,666		
TOTAL						$46,552				$81,219	$127,770		

DA FORM 5416-R, APR 85

COST200.WK3

MEMORANDUM

To: File, #3105.000
Fm: Ron Gerrans
Dt: 24 January 1992

Re: Bldg. 200, Helen Bradwell

We met with Helen Bradwell on 22 January 1992 to discuss building 200. The following information was discussed:

1. Lights: The lights are turned on by the first person in the area. The lights are supposed to be shut off by the last person to leave the area, but this seldom happens. The MP's turn off the lights during their rounds at 9:00. The janitorial staff comes through after that to clean the building, they turn the lights back on and usually do not turn them back off, even though they are supposed to. The MP's turn the lights back off during their 11:00 rounds. The exterior and parking lights are hooked up to the building power and use photocells to turn on and off.

2. Equipment: The central copy machines are on timers (6:00 a.m. to 6:00 p.m.), but the individual computers, copy machines, etc. are the responsibility of the individual to turn them off. They are usually shut off.

3. Occupancy: The times of occupancy vary, with the basement being on a 24 hour schedule, but the rest of the building on a normal 8:00 to 5:00 schedule. During the week there are approximately 1800 people in the building during the day, 100 during the night, and 200 - 300 on the weekends. During Desert Storm the entire building was occupied 24 hours per day. The equipment was only recently returned to normal operation.

4. Complaints: There is a problem in building 200 with keeping the occupants happy. It is common practice that if someone makes a complaint, they'll adjust their operations to make this one person happy.

Revise Lighting Control For Energy Savings

Individual offices lighting is presently controlled by local switching adjacent the doorways. There is no other control.

Wall switches and wiring to light fixtures will be removed. New occupancy sensors and power packs for connecting sensors to lighting fixtures will be installed to provide automatic lighting control switching by the occupancy sensor(s).

Occupancy sensor type, and locations for mounting whether wall or ceiling, will be reviewed on the configuration and size of individual offices.

It may be expected, based upon past projections and reports, the lighting energy consumptions of kilowatt-hours of power will be reduced 30-40 percent.

Open areas office spaces constitute approximately 70% of the building floor area.

Open office areas presently have lighting circuits controlled through low voltage relays mounted in low voltage relay panels adjacent building lighting panels from which the lighting circuits are derived.

Master selector switches for control of these lighting circuits are located in the open office areas.

For reduction of lighting in unoccupied areas and for energy savings the lighting control will be revised.

The existing low voltage lighting relay panels will be replaced by new "lighting automation panels" (LAPS) with provisions for automatic or telephone control.

LAPS will allow:

1. Remote control via telephone lines to control individual or all lighting control relays.
2. Control by new time clock which sweeps lighting on or off at preset times.
3. Local switch control via manual selector switches to remain.

E M C ENGINEERS, INC.	JOB Ft. McPherson / Ft. Gillem ESOS Study
Denver • Colorado Springs • Atlanta • Germany	SHEET NO EMC # 3105.000 OF
	CALCULATED BY DATE
	CHECKED BY DATE
	SCALE

Bldg. M-200 Lighting Control

Current Conditions

Energy Consumption

Overhead lighting = 600,316 W -from calculation
Floor Area = 274,200 ft^2
Task lighting = 0.67 W / ft^2 -from calculations

$$\text{TOTAL} = 0.67\ W/ft^2 + \frac{600{,}316\ W}{274{,}200\ ft^2} = 2.86\ w/ft^2$$

Lighting Schedule

	% lights on	
Hour	Weekdays	Weekends
0:00	5%	5%
7:00	80%	
8:00	100%	30%
12:00	80%	
13:00	100%	
16:00	80%	
17:00	60%	5%
21:00	30%	
23:00	5%	

-basement always 100% on

Savings

Enclosed Offices

30% of building is enclosed offices
Occupancy sensors in enclosed offices = 30% savings
-from ASHRAE 90
Savings = 30% * 30% * 600,316 W = 54,028 W saved

Cubical Area

70% of building is cubicles
Programmable lighting control = 15% savings
-from ASHRAE 90
Savings = 70% * 15% * 600,3166 W = 63,033 W

Energy Reduction

Overhead: 600,316 - 54,028 - 63,033 W = 483,255 W

$$\text{TOTAL:}\ 0.67\ W/ft^2 + \frac{483{,}255\ W}{274{,}200\ ft^2} = 2.43\ W/ft^2 = 15\%\ \text{reduction}$$

A Simple Approach To Lighting Automation

Ten years of leadership in lighting automation has taught us one very important lesson ... Keep It Simple!

TLC does this for lighting automation by marrying a simple product concept with support services.

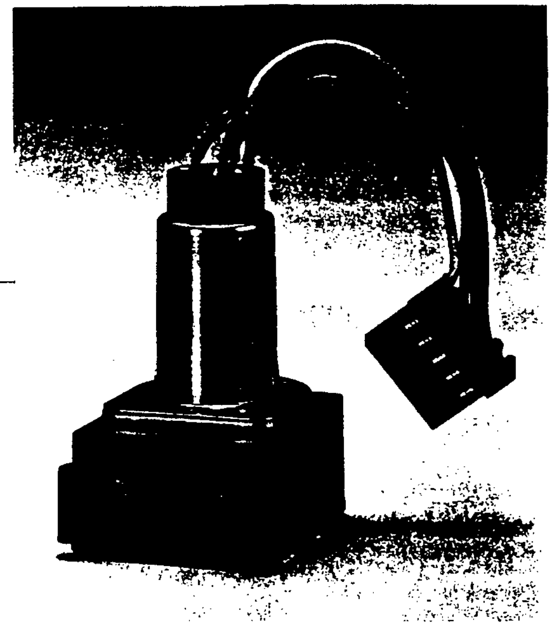
The Product Concept

TLC uses a plug-in version of the standard 20 amp, 277 volt RR9 relay as its basic building block. These control the power to each lit space.

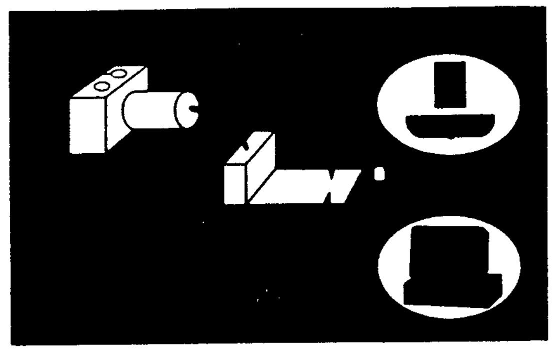
Each relay may be directly controlled by a low voltage switch, occupancy sensor or combination of both. This direct switching operates totally independently of any automation function. However, the relay panels will also accept plug-in intelligence cards which allow the system to be automated while still responding to direct overrides.

Different plug-in automation cards allow you to choose the level of automation:

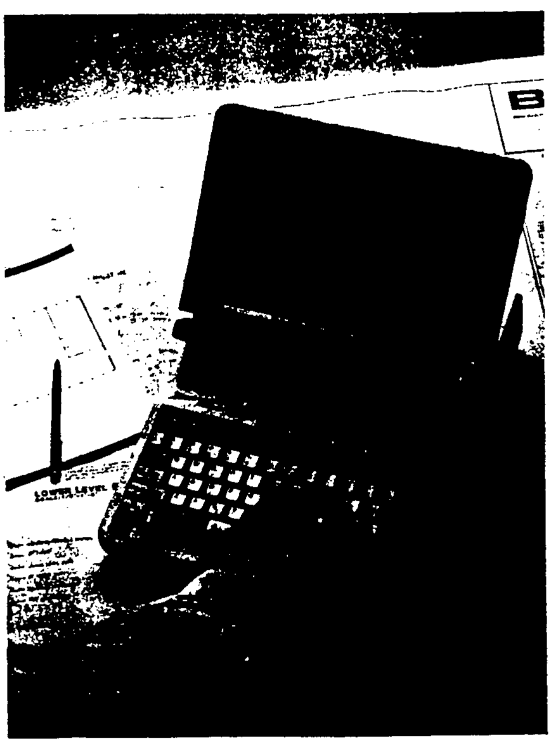
- from simple timeclock control ...
- to a networked programmable lighting control system ...
- to a totally integrated intelligent building system where the lighting is integrated with HVAC, fire, security and card access.



RR9P Relay



The Support Concept



GE TLC backs up the designer, installer and owner with the personal support necessary to ensure that your design time is minimal, that the installation is trouble-free and that the system performs as expected for years to come.

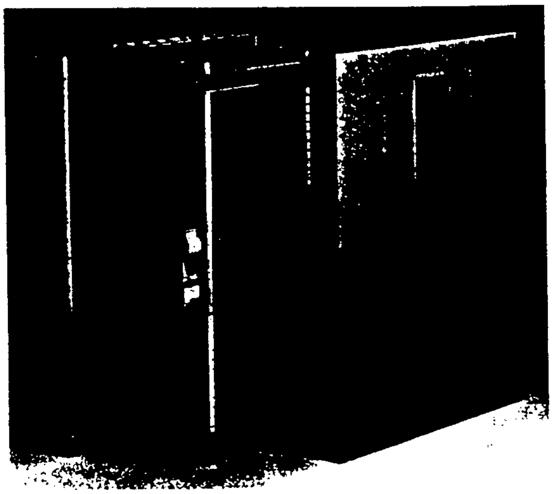
This manual explains the TLC product buildup, features and application principles. Before laying out an entire system, you may wish to ask your local TLC representative for a **TLC Options Analysis** to compare the cost/benefits of different approaches. He can also supply you with other design tools such as Typical Wiring Drawings, Guide-form Specs and Application Examples which will minimize your design time and ensure a smooth installation.

TLC Low Voltage Switching . . . The Foundation For Lighting Automation

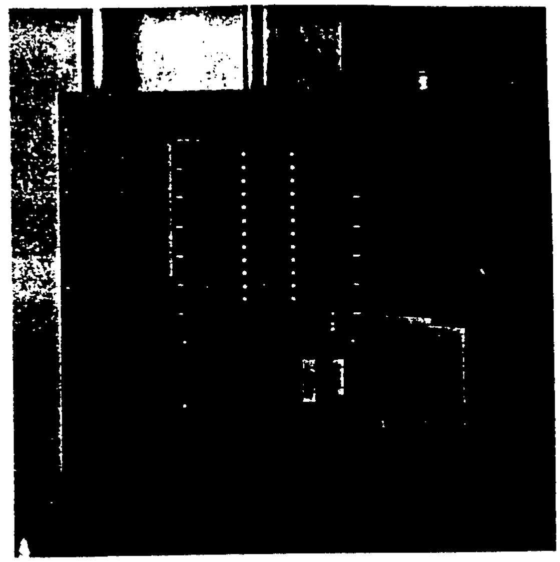
The TLC low voltage switching (LVS) provides the foundation for a range of automation options from simple Master On/Off Control to a Programmable, Networked System. The relays used to control each lit space are provided in modular panels called Lighting Automation Panels (LAP) which mount in the electrical closet. All local switches and occupancy sensors are wired back to the panel with Class 2 wiring.

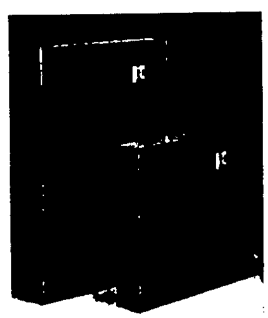
TLC uses a fully distributed control concept. The low voltage switches and occupancy sensors can continue to operate should a panel intelligence module fail. This allows the benefits of computer-based automation to co-exist with the simplicity and security of direct relay switching.

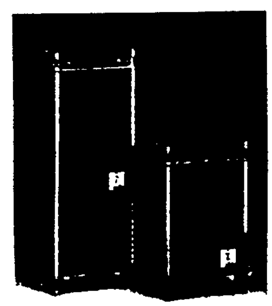
TLC Lighting Automation Panels (LAP)

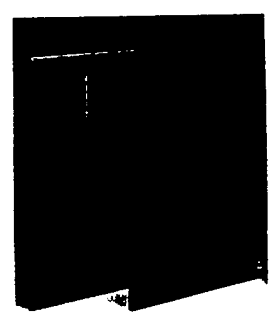


Tub *Interior with Power Supply* *Cover*









The Lighting Automation Panels are available in either a 24- or 48-relay maximum configuration. Each panel consists of a:

Tub
- A simple, low cost box which can be shipped to the jobsite early for rough-in wiring

Interior
- Prewired RR9P, plug-in type relays rated at 20 amp, 277 volts (additional relays simply plug-in)
- LED status indication for each relay
- Color-coded terminations for pilot light (or standard) low voltage switches or occupancy sensors
- Expansion slots for plug-in intelligence cards

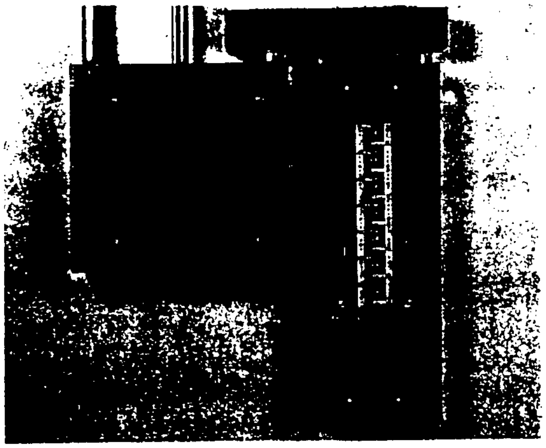
Power Supply
- Two transformers (one for the low voltage switching, the other for electronics) with internal overload protection
- GE-MOV voltage spike protection

Cover
- Standard shoebox or hinged, lockable configuration
- Wiring directory

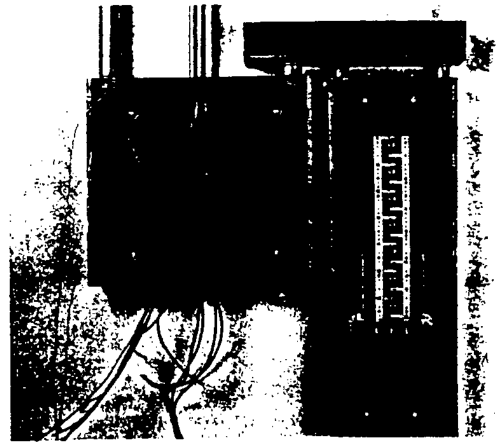
See page 24 for individual product catalog numbers and their corresponding spec (submittal) sheets. The latter provide a more detailed technical description.

TLC LAP Installation

Mount Tub



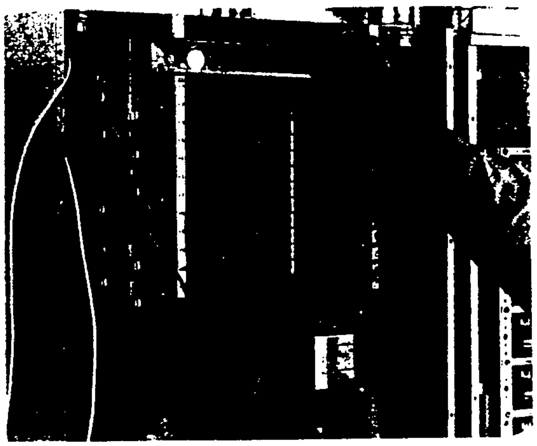
Mount the tub next to the lighting distribution panel.



Run line voltage wiring from circuit breaker to tub and switched circuits from tub to areas.

Mount Interior

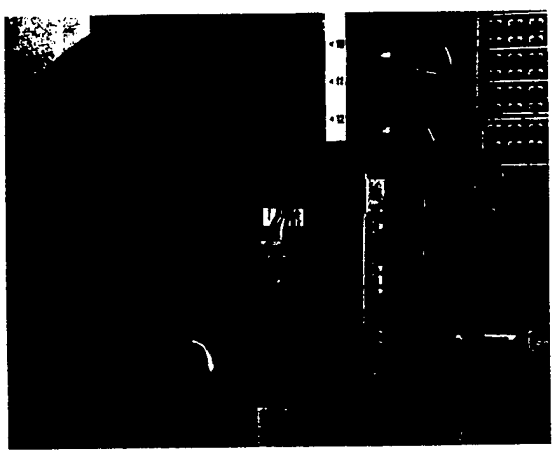
Install Power Supply



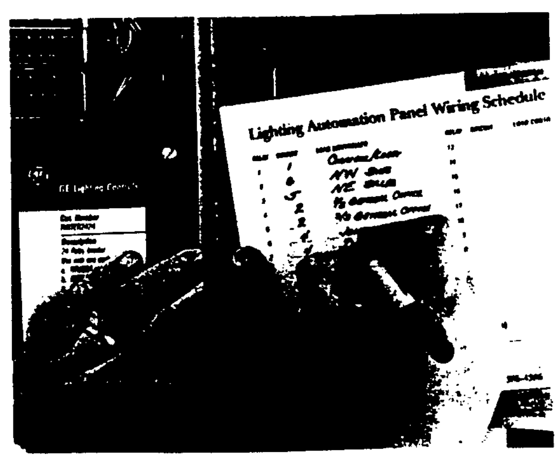
Slide the interior into the tub and secure.

Mount the power supply to the interior and plug in.

Connect Line Voltage Wiring



Connect line voltage wiring to the relays and power supply.

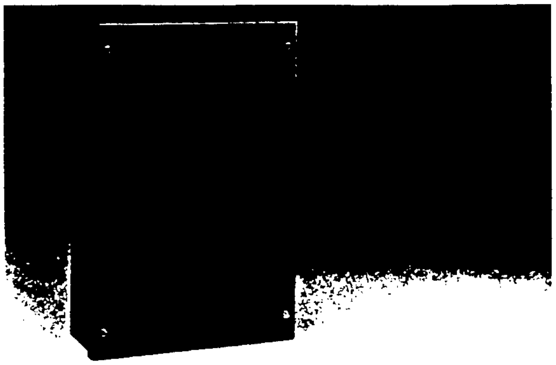


Install cover. Record all connections on the Wiring Schedule Card on the rear of the cover. Power up.

All lighting in the area is now under TLC relay control. Proceed to add direct switches and occupancy sensors.

Networked Intelligent Panels

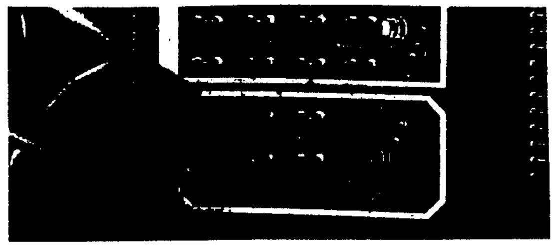
Set panel address.



Install dataline power supply.

The controller card also supports dataline communications. The first step is to assign each panel in the system a different address (001-999) by simply setting the digits on the controller card. The dataline power supply provides communications power and a fault detection/clear function. The dataline itself is a low cost twisted pair which can be run as a single line, looped or branched. Up to 500 lighting automation panels (24,000 relays) may be installed on a single dataline.

The dataline communications network opens up a power set of system options.



Run dataline

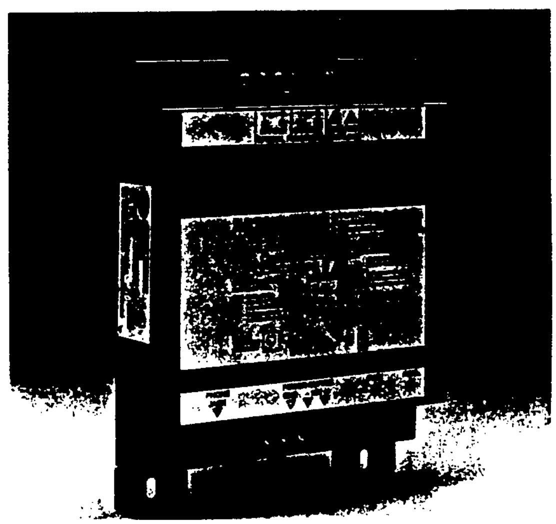
Telephone Option

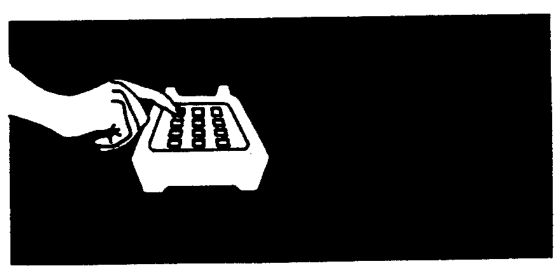
The Telephone Override Module (RPHONE) allows the existing Touchtone® phones in the building to control any relay or group of relays on the dataline. The RPHONE listens to a standard telephone extension. When a user calls the extension and enters his 4-digit ID code followed by a "1#", that code and an ON action request is transmitted over the dataline.

Individual relays which have been programmed to respond to that code will do so. The action is the same as an occupant hitting his local switch ON... the Telephone is a replacement for a local switch.

Note that the response to the telephone code is dictated by the controller's program data in each panel. This data may be entered at each panel or from a central location. Each relay in a panel can respond to up to eight different telephone codes and any number of relays may be programmed to respond to the same code.

The RPHONE includes two special function switch inputs. The first limits the phone override to "ON" only when the contact is closed. The second disables the phone override completely. When this contact is open, the RPHONE will not answer incoming calls (the telephone rings but there is no response). These two special function inputs allow the operation of the telephone to be modified for different times of the day or building occupancv.





A Simple Step

The TLC LVS that you just specified was the most time consuming part of the design process. The foundation is now in place for complete lighting automation.

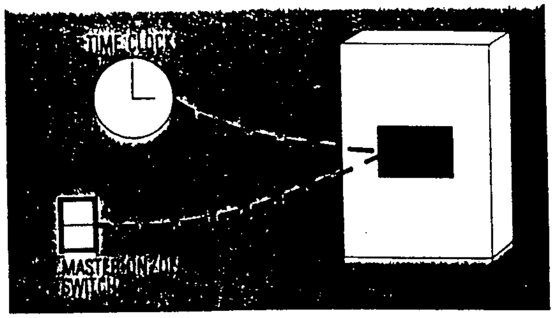
The TLC LVS design determined the number and size of lighting automation panels required by your project. These include slots for adding automation cards.

Simple Panel Master On/Off Control

The lowest level of automation simply adds a Master On/Off function to the panel.

A Master Switch or Timeclock input to the panel turns the relays on/off while still allowing the direct local switches to override their associated relays. Occupancy sensor controlled areas can be excluded from these sweeps.

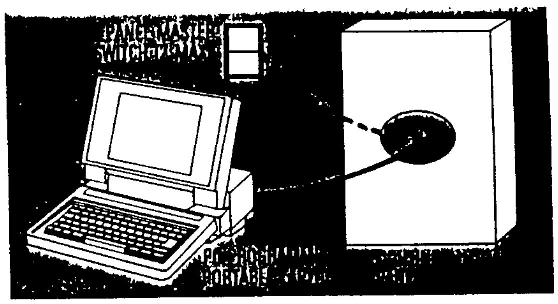
Since it's basic, we color it BLUE.



Programmable Panel Intelligence

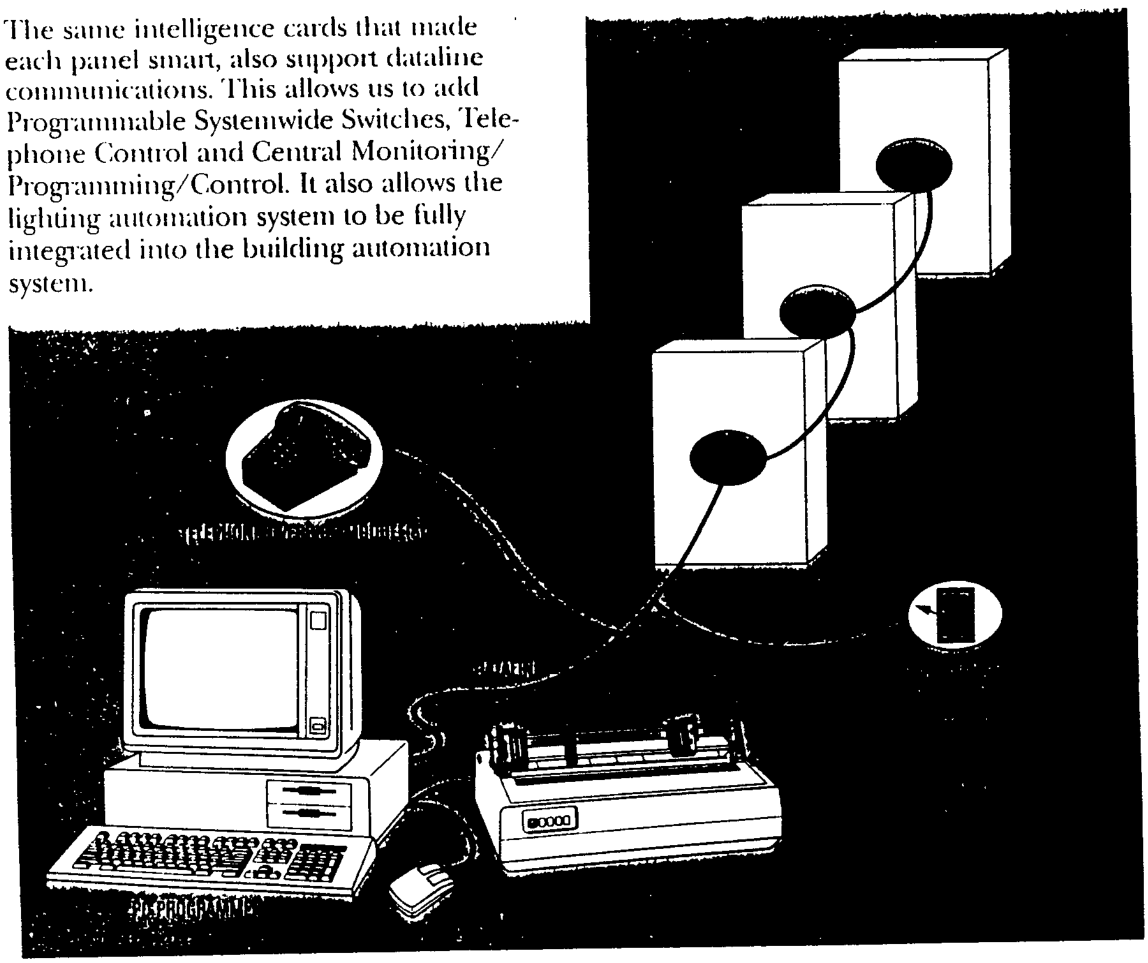
Adding programmable cards allows intelligent panel operation. Individual relays can be scheduled, programmed to "flick" warn before going off, and the direct switch can now override the automation without the lights going off first.

Energy savings potential increases as does sensitivity to the needs of occupants . . . color it GOLD.



Networked Intelligent Panels

The same intelligence cards that made each panel smart, also support dataline communications. This allows us to add Programmable Systemwide Switches, Telephone Control and Central Monitoring/Programming/Control. It also allows the lighting automation system to be fully integrated into the building automation system.



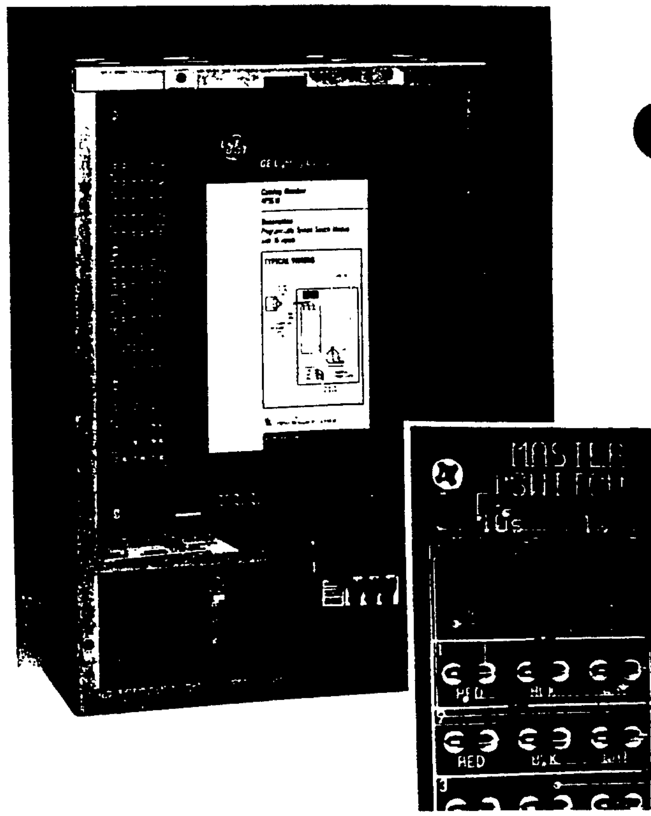
Programmable System Switches

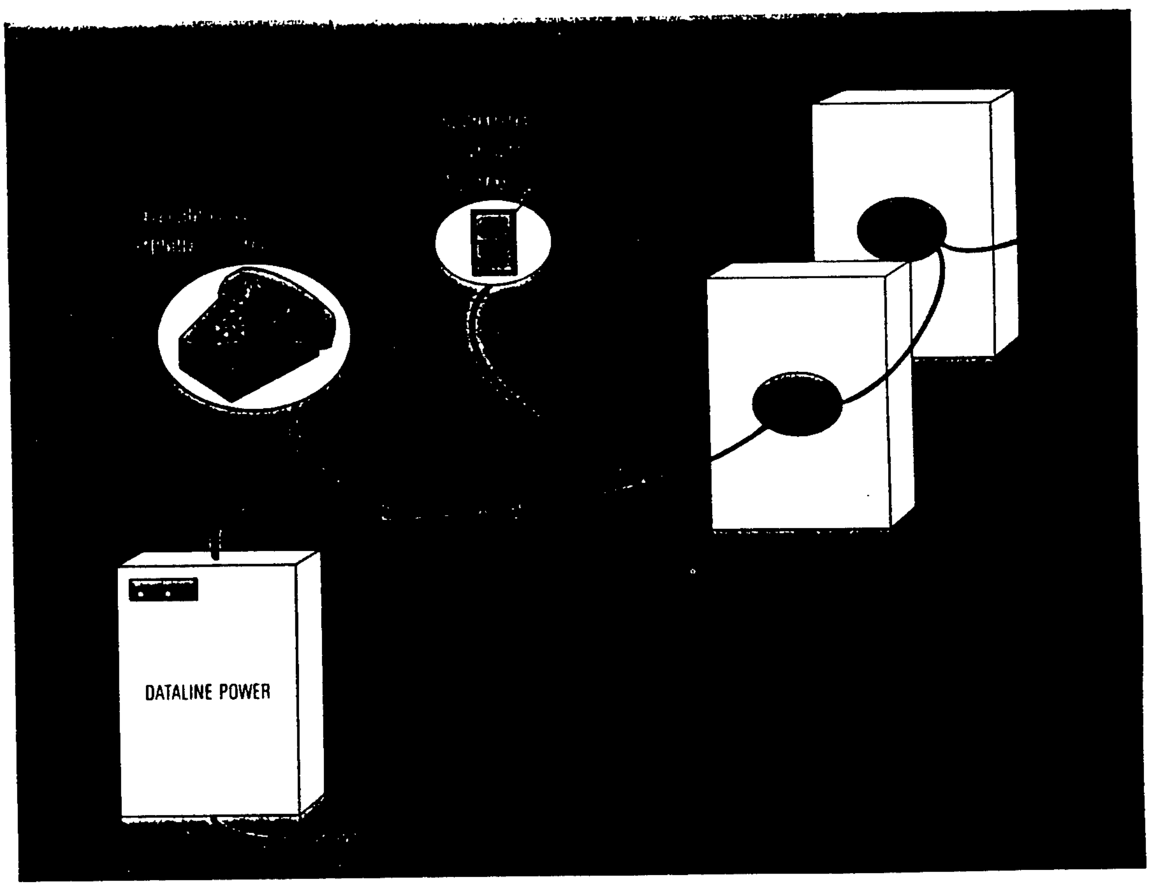
The Programmable System Switch Modules (PSS) provide systemwide intelligent switching functions. Each switch input may be programmed to control any group of relays in the system and each may be assigned one of four different operating scenarios:

- **Master On/Off**
- **"Flick"**
- **Cleaning**
- **Shed**

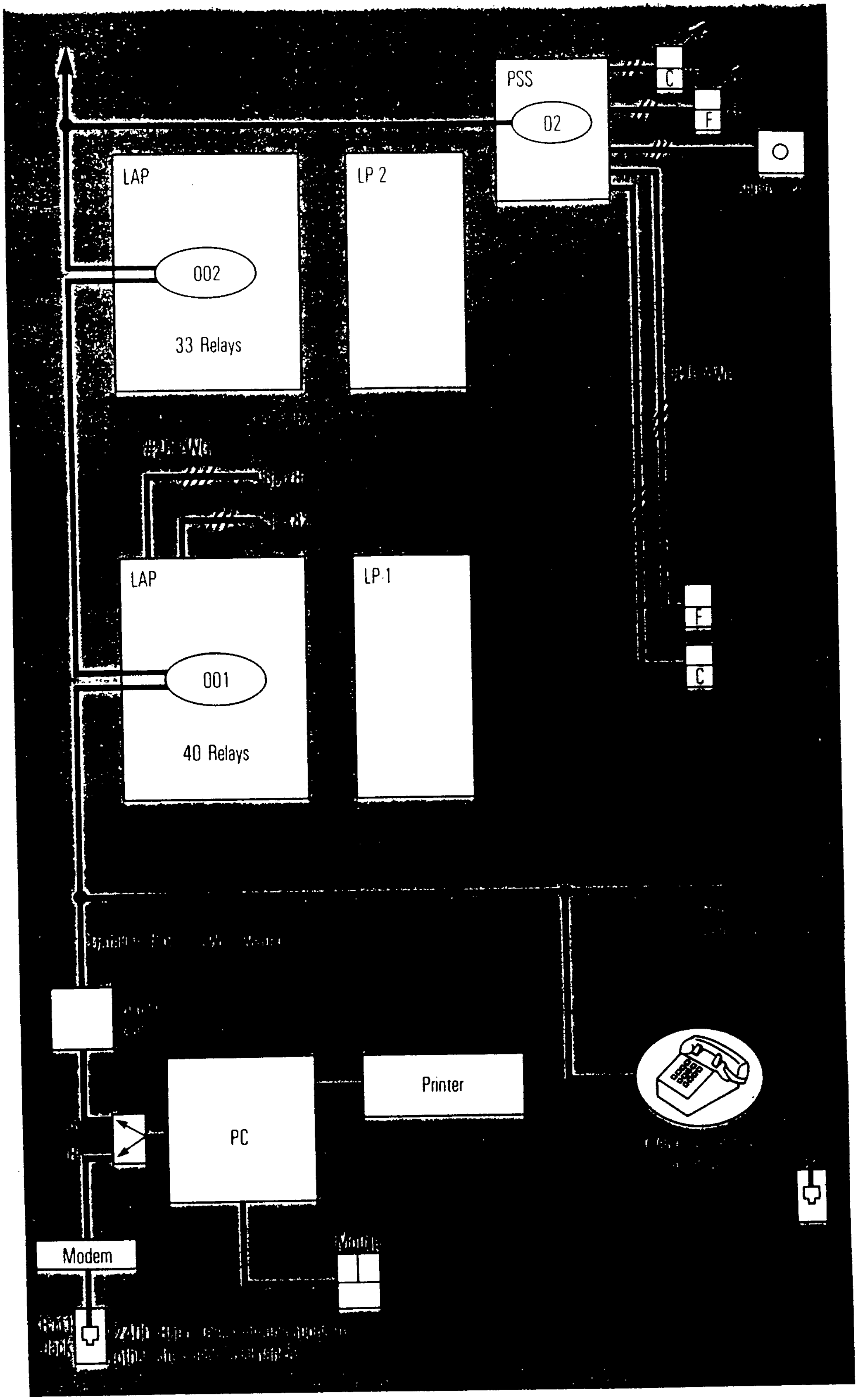
A PSS input does on a systemwide basis what a Programmable Panel Switch does on a panel basis. Each PSS has a two digit address (01-99) and 16 3-wire inputs. Like the RPHONE, the PSS transmits a switch identification (address/input) and the action (on/off). The response to this message on the dataline is determined by the program data in each panel's controller. Each relay may respond to:

- **8 Master On/Off**
- **8 Flick**
- **4 Clean**
- **1 Shed**





Typical 1-Line



GE Lighting Controls

TLC Options Analysis

Using this form

Purpose

This Options Analysis simplifies your lighting automation design process by allowing you to quickly evaluate the relative cost and performance of different levels of lighting automation in your facility.

What you will need

The **TLC System Overview (GEA-11868)** provides all of the necessary background material required to understand the Total Lighting Control system.

You'll also need a reflected ceiling plan (or floor plan) for a typical area fed by a single electrical closet.

What you must do

1. Fill in the project identification data to the right.
2. Mark up your reflected ceiling plan as illustrated on pages 3 and 4 of this form.
3. Fill in the blanks in the highlighted areas on pages 4 and 5.
4. Return the entire completed form and your marked up reflected ceiling plan to your local GE TLC representative or send it to:

GE TLC Assistance
100 40th Place North
Birmingham, AL 35222

If you have any questions, call your local representative or 1-800-TLC-ASST.

What we will do

Provide you with an analysis for each option you selected which will include:

1. Cost of Controls Hardware
2. Feature Summary
3. Typical Guideform Spec
4. Typical 1-line
5. Typical Wiring Diagrams

Our local representative will review the analysis with you and provide further assistance.

Today's Date

Project Start Date

Project/Building Name

Street Address

City

State ZIP

Owner's Name

Address

City

State ZIP

Engineer's Name

Company

Address

City

State ZIP

Your Name

Company

Address

City

State ZIP

Telephone Number

Note: Each analysis is based on the low voltage switching configuration which you specify on your marked up reflected ceiling plan. If you wish to compare different types of switching (such as ON/OFF vs. multiple level), or if you have distinctly different areas within your building, submit a reflected ceiling plan and form for each.

Step 1 Lay Out Low Voltage Wiring

The GE TLC low voltage wiring system provides the foundation for your facility automation. Relays are used to control the power to each lit space. These are provided in pre-assembled panels which mount in the electrical closet.

Determine Relay Count

Identify each area or load that you want to independently control. Then, for each area, decide whether you want simple on/off or multiple level control. This will determine the number of relays required.

On/off control requires one relay per area. Illustration **A** to the right shows Relay 1 controlling 3-lamp fixture(s) on/off.

Typical **Multilevel** switching requires two relays as illustrated in **B.** In some applications, such as conference rooms, you may wish to use additional relays to create different lighting environments or scenes.

The **Multilevel On/Off Hi/Lo** configuration illustrated in **C** is recommended when you wish to use an occupancy sensor and still allow the occupant to select levels. It also works well with simple daylighting scenarios. The first relay controls power to the area; the other(s) select the level.

Determine Direct Overrides

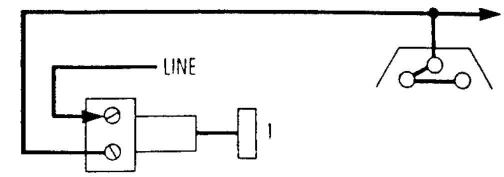
Each relay may be directly controlled by a low voltage switch, an occupancy sensor or a combination of both as shown in illustrations **D** and **E.**

The low voltage **Switches** may be either standard or pilot light type. Pilot light switches are recommended when the switched area is not visible from the switching location.

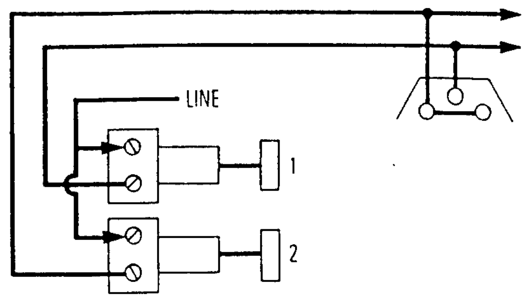
The **Occupancy Sensors** used with the GE TLC System provide coverage as follows:
One-way — 24 feet x 28 feet
Two-way — 24 feet x 56 feet
Hallway — 14 feet x 80 feet

All local switches and occupancy sensors are wired back to the relays using low voltage wiring. These wires can normally be run above the ceiling without expensive conduit. The standardized documentation makes design and installation simple.

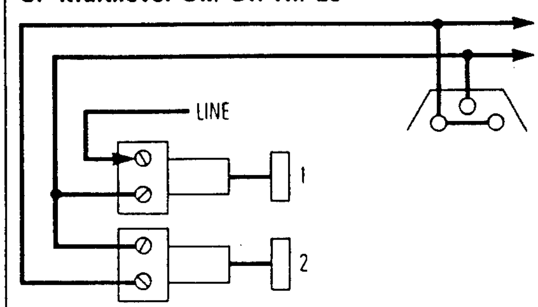
A. On/Off



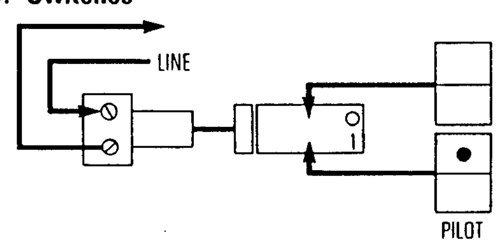
B. Multilevel (Off, 1/3, 2/3, On)



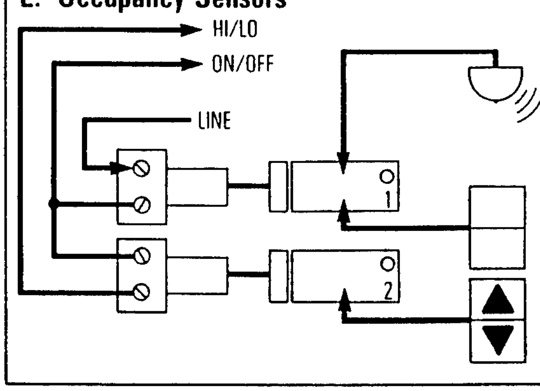
C. Multilevel On/Off Hi/Lo



D. Switches



E. Occupancy Sensors

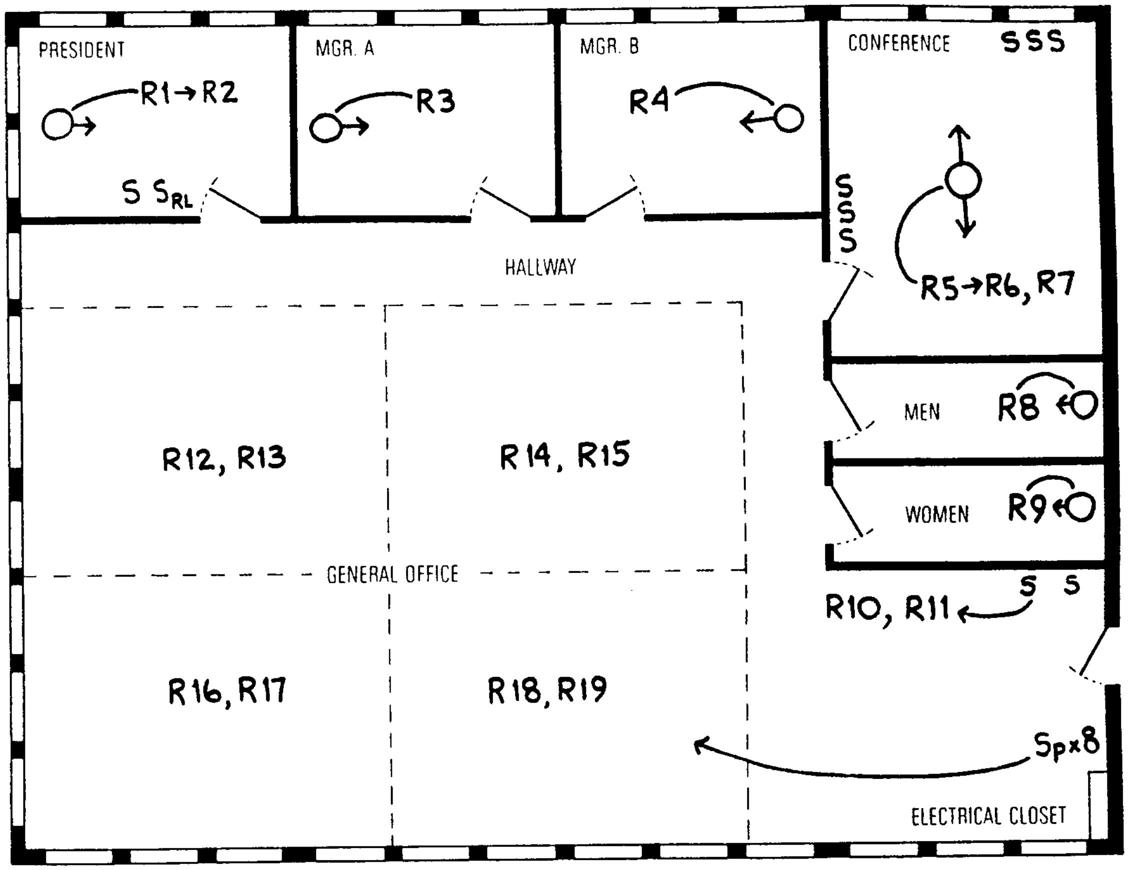


Example

Once you've determined the number of relays and the direct switching requirements, record your decisions on your reflected ceiling plan by using the symbols shown below. Then, simply number the relays sequentially from 1 to 48.

Symbols	Relay Wiring	Switches	Occupancy Sensors
	On/Off . . . . R__	Standard . . . . S	One way . . . . ←O
	Multilevel . . . . . . R__, R__	Pilot Light . . . . . . S_P	Two way . . . . ←O→
	On/Off Hi/Lo . . . . R__→R__	Hi/Lo . . . . S_{RL}	Hallway . . . . ←Ⓗ→

Reflected Ceiling Plan showing low voltage wiring



For your typical panel location ...

1. How many relays? . . . . ____
2. How many standard switches? . . . . ____
   Pilot light switches? . . . . ____
3. How many 1-way occupancy sensors? . . . . ____
   2-way occupancy sensors? . . . . ____
   Hallway occupancy sensors? . . . . ____
4. Average low voltage switchleg length (from electrical closet to switch) in feet? . . . . ____
   Do they run through an air-handling plenum? . . . . . Yes ____ No ____

How many panel locations similar to this one? . . . . ____

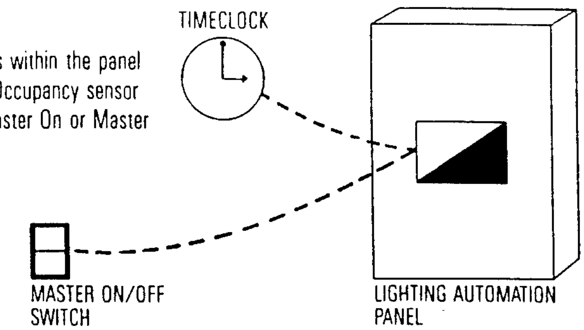
Step 2 Specify System Automation

The low voltage wiring which you just specified determined the quantity and size of the Lighting Automation Panels required for your project.

These panels provide slots for adding automation as described in the **TLC System Overview**. Simply check off the options that you wish to evaluate in the sections below.

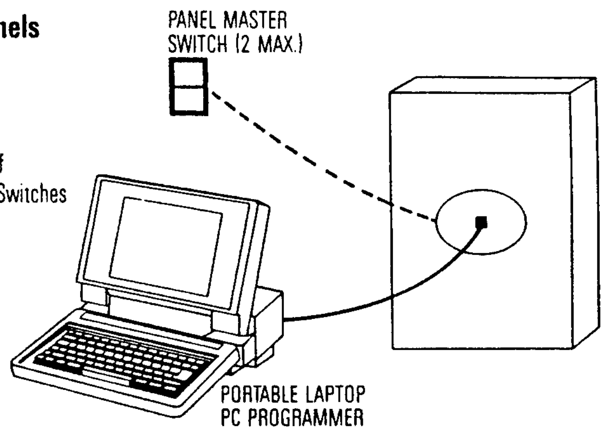
☐ Basic Panel Master On/Off

Master On/Off control of any or all relays within the panel while still allowing local switch override. Occupancy sensor areas can be excluded from either the Master On or Master Off if desired.



☐ Programmable Intelligent Panels

Stand-alone Operation:
- Schedule each relay
- Time Delay for overrides
- Flick Warning before scheduled Off
- Two Programmable Panel Master Switches



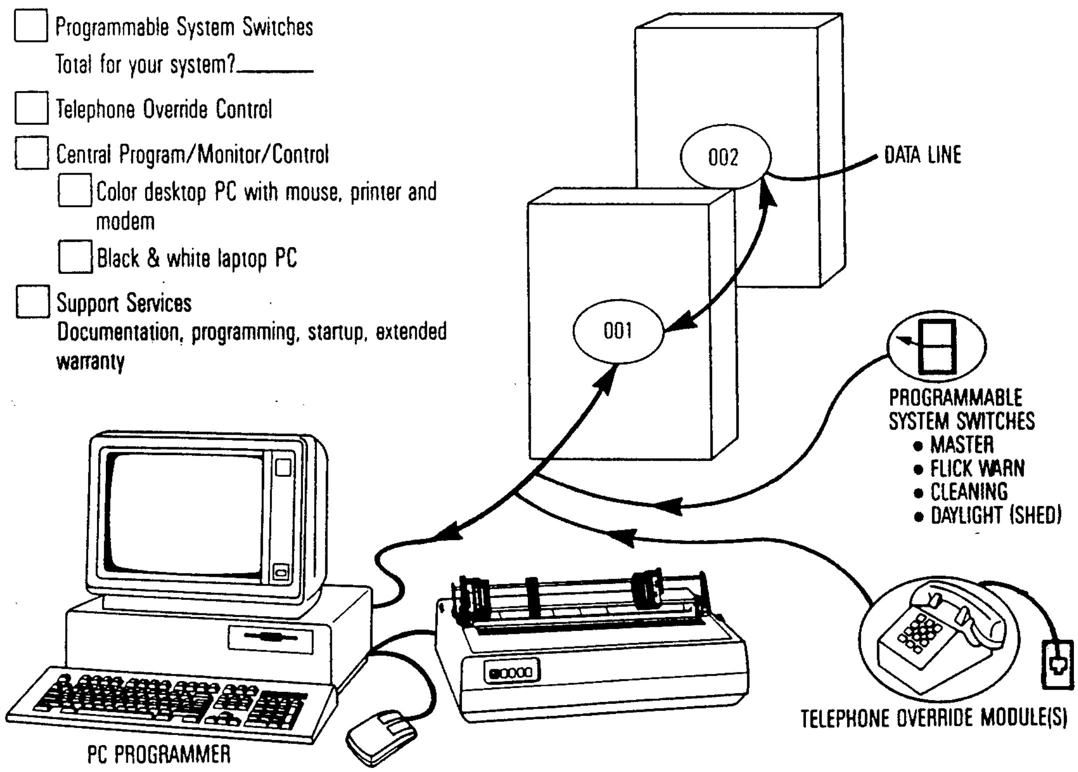
Network Options

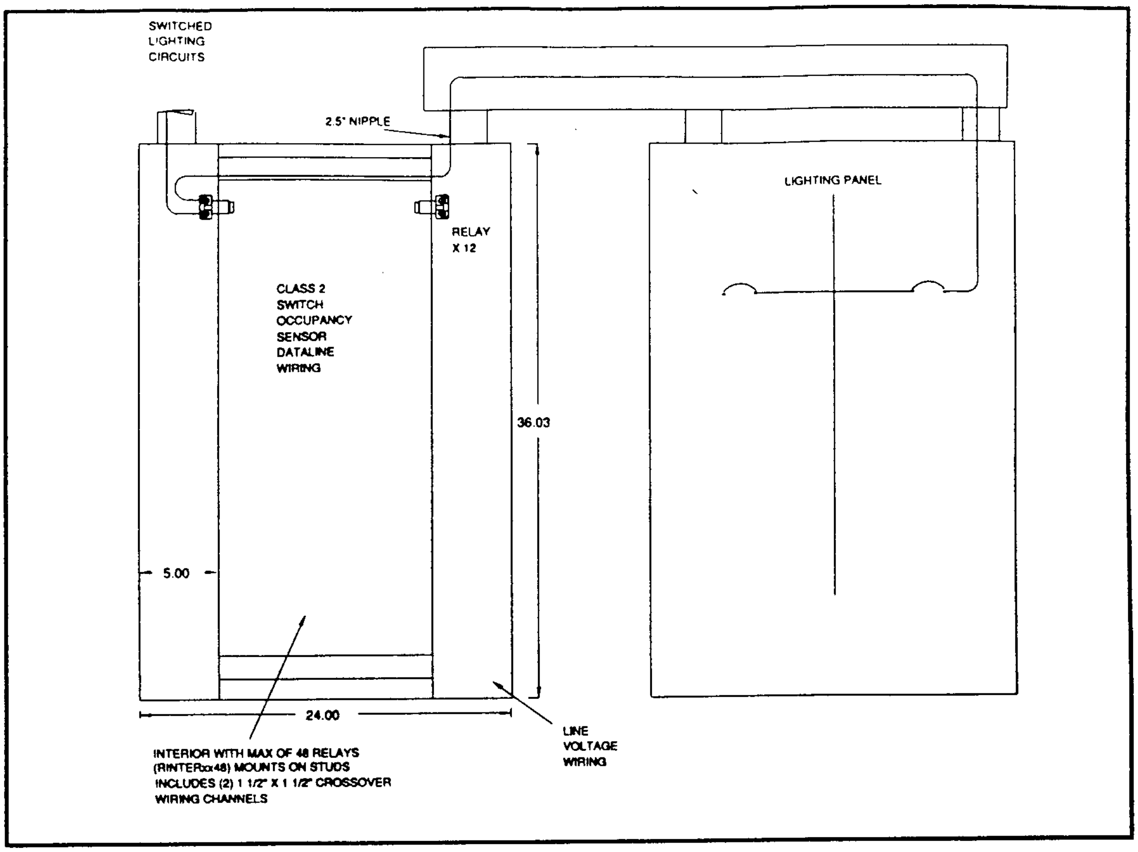
☐ Programmable System Switches
Total for your system?______

☐ Telephone Override Control

☐ Central Program/Monitor/Control
- ☐ Color desktop PC with mouse, printer and modem
- ☐ Black & white laptop PC

☐ Support Services
Documentation, programming, startup, extended warranty





ENVIRONMENT

Mount in indoor area

- *32° to 131° (0° to 50° C)*
- *10 to 95% relative humidity, non condensing*
- *15 volts/meter, 10 KHz-2GHz max RFI*
- *Stationary applications.*

MOUNTING

Orientation

- *Tub should be level, plumb, and rigidly installed with hardware sufficient to hold 100 lbs (46 kg) minimum*
- *Nameplate label should be in upper right corner.*

Flush Mount

- *Front flange should be flush with final finished surface.*

Multiple Panels

- *For surface mounting, allow a minimum of 1/4" between adjacent panels for shoebox cover clearance*
- *For flush mounting, allow a minimum of 1 3/4" (butt alignment of flush fronts) between the outside tub surfaces.*

WIRING

Line Voltage

- *Route line voltage wiring for the relays and power supply through the 2 1/2" knockouts in either the top or bottom of the tub. (You may also add holes and route through either vertical sidewall).*

Low Voltage

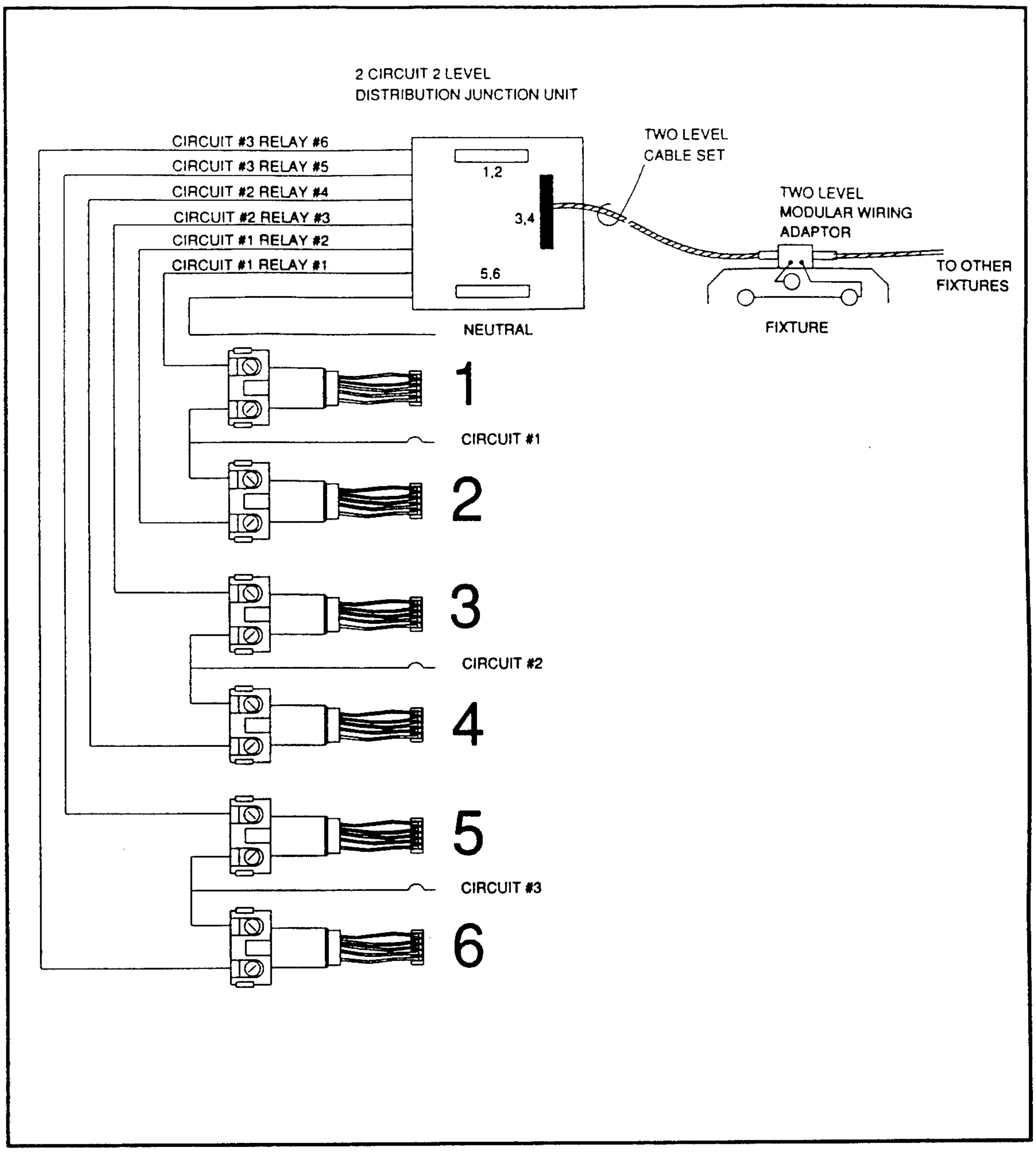
- *Route Class 2 wiring from switches and dataline (if used) through the 3/4" knockouts in either end.*

Low Voltage Switch Wire

- *Standard 20/3 Red, Black, White*
- *Pilot 20/4 Red, Black, White, Yellow*
- *Occupancy Sensor 20/4 Red, Black, White, Yelow*

CAUTION Use plenum rated (Class 2P) wire if routing through air handling plenums or risers without conduit.

- *See low voltage switch and occupancy sensor typical wiring configuration drawings for details.*

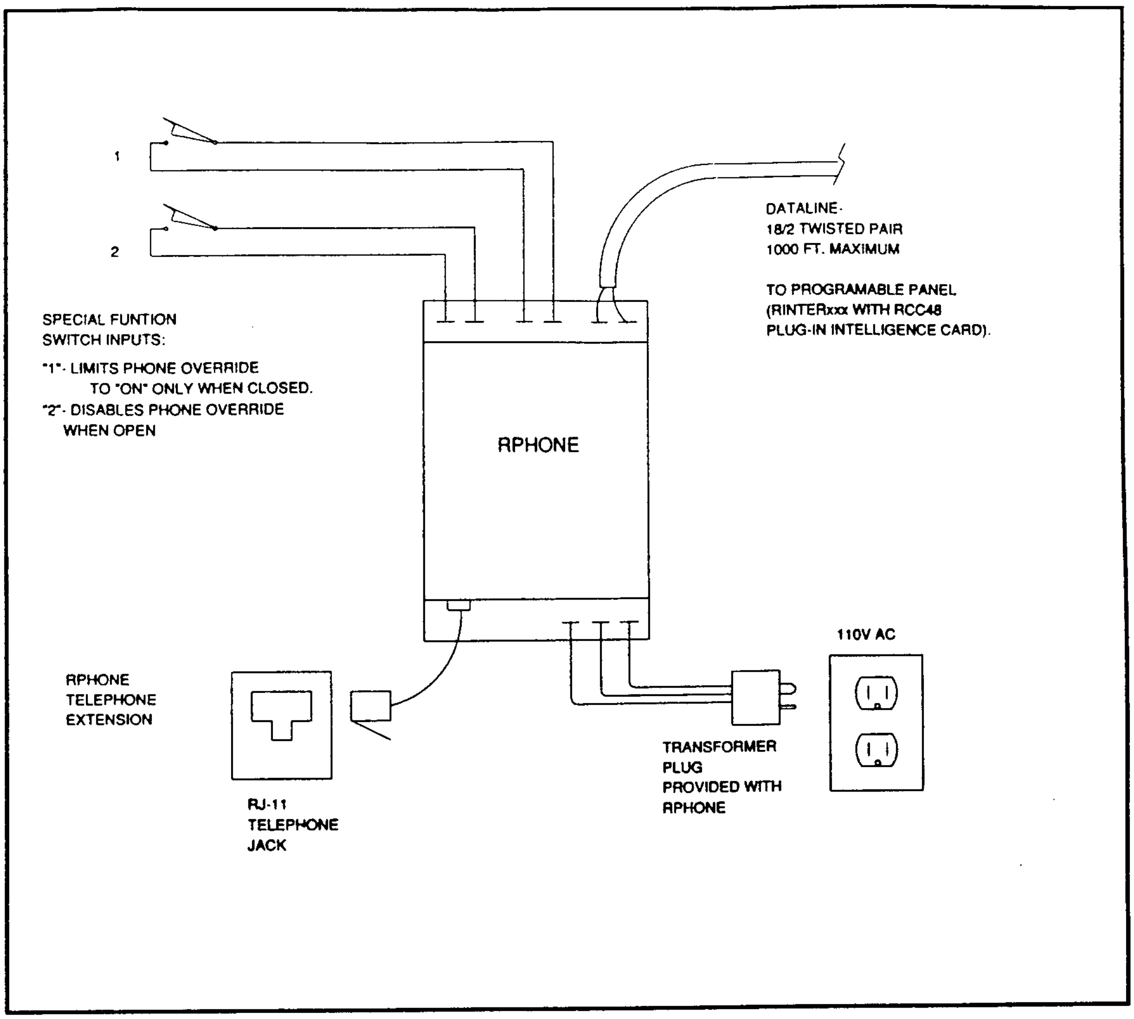


MULTILEVEL FLEX POWER WIRING

Modular or Flex wiring enhances the control flexibility of low voltage switching by allowing the fixture groups to be readily reconfigured. Low voltage switch and occupancy sensor wiring is run (normally without conduit) from the local zone back to the Lighting Automation Panel.

WIRING

- *Wire from breaker to relay per wiring schedule*
- *Route from relays to distribution junction box in the switched area. Identify all switched circuits with the relay number (1-48).*
- *Label the connectors on the junction box with the associated relay numbers.*



DESCRIPTION
Telephone Override Module
The telephone override allows any Touchtone (Dual Tone Multiple Frequency) phone to override any individual relay or group of relays. The RPHONE plugs into a standard RJ11 telephone extension.

SPECIFICATIONS
Description
Telephone Override Module

Operating Environment:	*0-55 Degrees C (32-131 F)* *0-95% RH, Non Condensing* *Non Corrosive atmosphere*
Mounting:	*Wall Mount*
CODES:	*UL 916 Energy Management*

APPENDIX C-18

EXIT SIGN RETROFIT

ECO-18, REPLACE EXIT SIGN BULBS WITH FLUORESCENT BULB KITS

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: MECO25
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-18 EXIT SIGN RETROFIT
ANALYSIS DATE: 07-09-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	14858.
B. SIOH	$	818.
C. DESIGN COST	$	892.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	16568.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	351.	$ 2620.	15.61	40902.
B. DIST	$ .00	0.	$ 0.	21.66	0.
C. RESID	$ .00	0.	$ 0.	26.51	0.
D. NAT G	$ 4.67	0.	$ 0.	23.77	0.
E. COAL	$ .00	0.	$ 0.	16.06	0.
F. TOTAL		351.	$ 2620.		$ 40902.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 23.
(1) DISCOUNT FACTOR (TABLE A) 14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 334.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 334.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 13498.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 2643.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 41236.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 2.49
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 6.27

REPLACE EXIT SIGN BULBS SAMPLE CALCULATION, ECO #18
BUILDING 41

Given:

# of Exit Signs	= 4 signs	- from field survey
Existing Bulb Wattage	= 40 Watts	- from field survey
Improved Bulb Wattage	= 10 Watts	- from manufacturer's data
Gas Cost	= $4.67 / MBtu	- from utility rate analysis
Electric Cost	= $0.0255 / kWh	- from utility rate analysis
Demand Cost	= $8.85 / kW	- from utility rate analysis

Existing Energy Usage:

(4 signs)*(40 Watts / sign) = 160 Watts
(0.16 kW)*(8,760 hrs / yr) = 1,402 kWh

Improved Energy Usage:

(4 signs)*(10 Watts / sign) = 40 Watts
(0.04 kW)*(8,760 hrs / yr) = 350 kWh

Peak Demand Savings:

(0.16 - 0.04 kW) = 0.12 kW

Annual Energy Savings:

- Electric:	(1,402 - 350 kWh)	= 1,052 kW
- Gas:		= 0 MBtu

Annual Energy Cost Savings:

(0 MBtu)*($4.67 / MBtu) + (1,052 kWh)*($0.0255 / kWh) + (0.12 kW)*($8.85 / kW)*(4 + .95 * 8) = $39 / yr

Annual Increased recuring cost

($7.95) - (2 * $2.25) * (8,769 yr / 10,000 hr) = $3.02 / yr / fixture
4 fixtures = 4 * $3.02 = $12.08 / yr

Estimated Construction Cost:

$38.00 / sign - from engineer's cost estimate

($38.00 / sign)*(4 sign) = $152

$152 + ($152 * .055 SIOH) + ($152 * .06 DESIGN) = $169

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: **REPLACE EXIT SIGN LIGHTING WITH FLUORESCENT LIGHT RETROFIT KIT**

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 07/17/92
FILE: EXITLITE.WK3
PRPARED BY: CAMERAN DIBAI
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
INCREMENTAL GAS COST	$4.67 MBtu	23.77 UPWG
INCREMENTAL ELECTRIC COST	$0.0256 kWh	15.61 UPWE
ELECTRIC DEMAND CHARGE	$102.66 kW	14.53 UPW
ECONOMIC LIFE	25 YRS	

ESTIMATED 8760 HOURS OF EXIT LIGHTING PER YEAR

BLDG	NUMBER OF FIXTURES	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWH)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND SAVINGS ($)	ANNUAL NON-ENERGY SAVINGS ($)	TOTAL ANNUAL SAVINGS ($)	CONST. COST ($)	SIR	SIMPLE PAYBACK (YRS)
41	4	0.12	1,051	0	4	$27	$12	($12.08)	$27	169	2.5	6.2
56	12	0.36	3,154	0	11	$81	$37	($36.24)	$81	508	2.5	6.2
58	12	0.36	3,154	0	11	$81	$37	($36.24)	$81	508	2.5	6.2
60	17	0.51	4,468	0	15	$114	$52	($51.34)	$115	720	2.5	6.2
62	12	0.36	3,154	0	11	$81	$37	($36.24)	$81	508	2.5	6.2
101	12	0.36	3,154	0	11	$81	$37	($36.24)	$81	508	2.5	6.2
170	20	0.6	5,256	0	18	$135	$62	($60.40)	$136	847	2.5	6.2
171	22	0.66	5,782	0	20	$148	$68	($66.44)	$149	932	2.5	6.2
181	30	0.9	7,884	0	27	$202	$92	($90.60)	$204	1271	2.5	6.2
184	24	0.72	6,307	0	22	$161	$74	($72.48)	$163	1017	2.5	6.2
200	100	3	26,280	0	90	$673	$308	($302.00)	$679	4237	2.5	6.2
246	21	0.63	5,519	0	19	$141	$65	($63.42)	$143	890	2.5	6.2
363	85	2.55	22,338	0	76	$572	$262	($256.70)	$577	3601	2.5	6.2
366	2	0.06	526	0	2	$13	$6	($6.04)	$14	85	2.5	6.2
400	10	0.3	2,628	0	9	$67	$31	($30.20)	$68	424	2.5	6.2
401	8	0.24	2,102	0	7	$54	$25	($24.16)	$54	339	2.5	6.2
TOTAL	391	11.73	102,755	0	350.701	2630.52	1204.2	-1180.82	2653.9	16567	2.5	6.2

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

EFFECTIVE PRICING DATE APR 92

DATE PREPARED 22-Apr-92

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

X CODE A | CODE B | CODE C | OTHER

DRAWING NO.

SHT OF

ESTIMATOR RMG

CHECKED BY CEL

TASK DESCRIPTION	Quantity No. Of Units	Quantity Unit Meas	LABOR MH/ Unit	LABOR Total Hrs	LABOR Unit Price	LABOR Cost	EQUIPMENT Unit Price	EQUIPMENT Cost	MATERIAL Unit Price	MATERIAL Cost	TOTAL	SHIPPING Unit Wt	SHIPPING Total Wt
EXIT SIGN RETROFIT KIT	1	EA	1	0.5	$21.17	$10.59			$15.00	$15.00	$25.59		
SUBTOTAL						$10.59				$15.00	$25.59		
OVERHEAD, BOND	15%					$1.59				$2.25	$3.84		
PROFIT	10%					$1.06				$1.50	$2.56		
COST SUB-TOTAL						$13.23				$18.75	$31.98		
CONTINGENCY	15%					$1.98				$2.81	$4.80		
TOTAL						$15.22				$21.56	$36.78		

DA FORM 5418-R, APR 85

ECO-19, PREVIOUS LIGHTING REVIEW STUDY, FOR LIGHT FIXTURE REPLACEMENTS

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: MECO25
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-19 LIGHT RETROFIT
ANALYSIS DATE: 07-09-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$ 644577.
B. SIOH	$ 35452.
C. DESIGN COST	$ 38675.
D. SALVAGE VALUE COST	-$ 0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$ 718704.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	5008.	$ 37413.	15.61	584017.
B. DIST	$ .00	0.	$ 0.	21.66	0.
C. RESID	$ .00	0.	$ 0.	26.51	0.
D. NAT G	$ 4.67	0.	$ 0.	23.77	0.
E. COAL	$ .00	0.	$ 0.	16.06	0.
F. TOTAL		5008.	$ 37413.		$ 584017.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 64368.
(1) DISCOUNT FACTOR (TABLE A) 14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 935267.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 935267.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 192726.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) 1.08
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 101781.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 1519285.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 2.11
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 7.06

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 19 – PNL Lights

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 14-Jul-92
FILE: ECO-19.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	23.77 UPWG
Electric Savings	$0.0255 / kWh	15.61 UPWE
Demand Savings	$8.85 / kW	14.53 UPW

Economic Life: 15 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON-ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
CCF	331	774,540	0	2,641	$19,751	$33,980	$0	$53,731	$297,132	2.7	5.5
Office	296	692,640	0	2,362	$17,662	$30,387	$0	$48,050	$421,571	1.7	8.8
TOTAL	627	1,467,180	0	5,003	$37,413	$64,368	$0	$101,781	$718,703	2.1	7.1

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 19 – PNL Lights

CLIENT CONTRACT NO: DACA21–91–C–0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 21–APR–92
FILE: ECO–19.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

Operation: 2340 hrs / yr

BLDG TYPE	EXIST DEMAND (kW)	IMPRVD DEMAND (kW)	COOLING DEMAND SAVINGS (kW)	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	TOTAL CONST COST ($)
CCF	507	255	79	331	774,540	$266,486
Office	710	414	0	296	692,640	$378,090

TRI-SERVICE MILITARY CONSTRUCTION PROGRAM (MCP) INDEX

CALENDAR YEAR	*1990	*1991	1992	1993	1994	1995	1996
JANUARY	1676	1742	1810	1875	1938	1999	
FEBRUARY	1679	1746	1813	1878	1941	2002	
MARCH	1682	1750	1816	1881	1944	2005	
APRIL	1686	1753	1819	1885	1947	2009	
MAY	1693	1760	1826	1891	1953	2015	
JUNE	1700	1767	1833	1897	1959	2021	
JULY	1706	1773	1839	1904	1966	2027	
AUGUST	1713	1780	1846	1910	1972	2033	
SEPTEMBER	1720	1787	1853	1916	1978	2039	
OCTOBER	1726	1793	1859	1922	1984	2045	
NOVEMBER	1731	1799	1864	1927	1981		
DECEMBER	1736	1805	1869	1932	1990		

Example: (For 10 Month Construction Period)

Submittal Date	- 1 Sept 90	1720	-- 13 Months
Bid Opening Date	- 1 Apr 91		
Contract Award Date	- 1 May 91		
Midpoint of Construction	- 1 Oct 91	1793	

Cost Growth Factor = 1793 / 1720 = 1.0424 Use 1.04

Use 4 % Per Fiscal Year For Projection Beyond FY 1997

* Historical

Cost Escalation

MCP Index

Report Date: 12/89 (use 1/90) 1676

Present Date 4/92 1819

Cost Growth Factor = 1819/1676 = 1.0853 use $\boxed{1.09}$

FEASIBILITY STUDY FOR
LIGHTING SHARED ENERGY SAVINGS PROJECT
FORT McPHERSON AND FORT GILLEM, GEORGIA

U.S. Army Corps of Engineers
Huntsville Division
Contract DACA87-89-D-0007
Delivery Order 0005

FINAL REPORT

July 20, 1990

The fixtures in the Generals' offices, Rooms 333, 336, and 339, should be changed to a 2 x 4 or a 2 x 2 louvered fixture the same style as Item 1. By installing fixtures as specified in Item 1, a maintained foot candle level of 60 FC will result, yielding a 78 percent reduction in wattage in comparison to the existing incandescent system estimated wattage of 7 kW. Installation costs are estimated at $1,608. The fixtures can be connected to two fluorescent dimming circuits to provide full control of the lighting level. Simple payback based on energy savings will be 3 years. Increased maintenance savings not included will shorten payback period.

The basement level or any areas without any artificial lighting could have a minimum number of fixtures powered by a battery system or by the building UPS system to provide continuous lighting during generator startup, (limited to 10 seconds by life safety codes), thus eliminating the interruption of critical operations due to a utility failure.

Exit signs with incandescent lamps should be replaced or retrofitted with fluorescent lamps which will give a lighting wattage reduction of 80 percent from an estimated load of 3 kW, and an increase in light output of over 65 percent. The installation cost is estimated at $2,220. The use of a Liquid Crystal Display (LCD) type is not recommended since LCD signs do not provide sufficient illumination to be visible during a fire emergency evacuation. Simple payback based on energy savings will be 1.5 years. Increased maintenance savings not included will shorten payback period.

3.7 CAPITAL COST ESTIMATE

3.7.1 Warehouse

The 11,100 existing fluorescent fixtures in use will be replaced with 4,964 High Pressure Sodium (HPS) fixtures at a cost of $1,255,900 (in 12/89 dollars). This does not include $273,000 for rewiring from 120 V to 277 V believed necessary for the warehouses because of the age and condition of the existing 120 V wiring. Because this rewiring should be done by the government anyway, we have assumed that it would be done by separate contract and should not be reflected in the SES analysis of potential costs and

benefits. Including the cost of rewiring will make it harder for the Third Party Contractor to meet his economic goals with the Shared Energy Savings Contract. However, the effect of rewiring on the gross payback will be included in Section 5. The unit cost of installing new HPS fixtures is $253/fixture. This includes the cost of the luminaire and lamp, and the cost of labor at $25/hr. The equipment cost is based on discussions with potential vendors.

The cost estimate is based on replacing the fixtures at Fort Gillem. Fort McPherson warehouses, although likely to be included in any retrofit program, contain only 5 percent of the total number of fixtures and was not included in the evaluation.

3.7.2 Office

The existing fluorescent fixtures will be replaced with parabolic louvered fixtures with energy-saving lamps and ballast arrangements. The cost will be $1,294,120 for both Fort Gillem ($702,765) and Fort McPherson ($591,355 including $244,483 for CCF), including the Comand and Control Facility. Unlike the warehouses, no supply rewiring is required.

3.8 MAINTENANCE COST ESTIMATE

3.8.1 Warehouse

The cost of yearly maintenance for HPS fixtures is based on group relamping at 75 percent of the lamp life. The procedure is similar to that described in Section 3.4. Maintenance includes the material and labor necessary to replace and clean lamps and to replace ballasts. Material costs are based on discussions with vendors. The average annual cost of maintaining the fixtures is $53,611.

SECTION 4

ENERGY COMPARISON

The lighting retrofit programs described in Section 3.5 for offices and warehouses offer significant energy savings. In the offices, switching to parabolic louvered fixtures and energy saving magnetic ballasts will result in the following:

	Fort Gillem	Fort McPherson	Total
Existing load (kW)	1,201	1,217	2,418
Future loads (kW)	718	669	1,387
Savings (kW)	483	548	1,031
Percent savings			43%

In the CCF alone, the load will be reduced from 507 kW to 255 kW, a reduction of 50 percent.

In Fort Gillem's warehouses, switching to High Pressure Sodium fixtures will reduce the lighting load from 1,705 kW to 918 kW, a reduction of 787 kW or 46 percent.

The savings are based on the energy reduction calculated by system characteristics (connected load and hours of operation) observed in the walkdown, compared to reduction in power of the recommended system.

The power cost savings will not be quite so high in percentage savings because of Georgia Power Company's declining block rate structure. The rates are as follows:

	Incremental Usage (kWh)	Rate ($/kWh)
<300 hr/mo * Billing Demand:	50,000	0.05710
(up to maximum of	150,000	0.05590
1,961,500 kWh)	800,000	0.04150
	961,400	0.03950
>300 hr/mo * Billing Demand:	Balance of kWh	0.01110

In addition, a fuel charge of $0.016045 is charged for every kWh of usage.

The lighting systems are assumed to be in use 9 hours/day, 5 days/week or an average of 195 hours/month.

Table 4-1 presents the existing and future power charges for all of the offices including the Command and Control Facility and for the CCF separately. Note that the average rate increases with the modification because a greater percentage of the power usage is shifted to the higher rates. The total bill for all office lighting, however, is reduced by 45 percent and for the CCF alone, by 50 percent. In addition to the power savings due to lighting system changes in the CCF, there will be a net decrease in power consumed for air conditioning. The CCF is cooled by a motor-driven chiller. The differential energy consumption was determined by modeling the building and HVAC system both before and after the proposed modification. The total annual energy reduction, including the effects on heating, is 184,552 kWh/yr. The HVAC load reduction of other buildings was not calculated because due to system sizes and usage patterns the energy reduction will be small compared to lighting energy reduction.

The energy cost savings may be overstated due to electric loads other than lighting. These additional loads will generally be unaffected by the proposed lighting system changes and therefore, reductions in lighting system loads may occur in lower rate blocks. The approach used is more optimistic for the value of savings.

The warehouse power charges are presented on Table 4-2. The average rate will increase from $0.066/kWh to $0.072 kWh, but the total bill will be reduced by 41 percent.

TABLE 4-1

OFFICE (ALL) POWER COST

Monthly Energy Rate which Includes Demand			Existing System Avg. 471,534 kWh/Mo		Modified System Avg. 270,314 kWh/Mo	
Hr/Mo	Incr. kWh	Rate	kWh	Cost	kWh	Cost
<300	50,000	$0.0571	50,000	$ 2,855	50,000	$ 2,855
	150,000	0.0559	150,000	8,385	150,000	8,385
	800,000	0.0415	271,534	11,269	70,314	2,918
	961,000	0.0395	0	0	0	0
>300	(Balance)	0.0111	0	0	0	0
Fuel	All kWh	0.016045	471,534	7,566	270,314	$ 4,337
				$30,074		$18,495
			Avg. Rate	$0.064/kWh		$0.068/kWh

COMMAND AND CONTROL FACILITY POWER COST

	Existing System			Modified System		
	kWh	@ Avg. rate from above	Cost	kWh	@ Avg. rate from above	Cost
Lighting Costs:	98,865	$0.064/kWh	$6,327	49,725	$0.068/kWh	$3,381
Differential Air Cond. Costs:	Base		base	-15,379	0.068	-1,046
			$6,327			$2,335

A/C Demand Savings = 15,379 kWh /(195 hrs/mo) = $\boxed{79}$ kW

APPENDIX D-2 QRIP PROJECT

ECO-8, INSTALL LOW-FLOW SHOWER AND FAUCET FIXTURES

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: MECO15
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-8 WATER FLOW RESTRICTORS
ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	9826.
B. SIOH	$	541.
C. DESIGN COST	$	590.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	10957.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	0.	$ 0.	11.11	0.
B. DIST	$ .00	0.	$ 0.	14.26	0.
C. RESID	$ .00	0.	$ 0.	16.89	0.
D. NAT G	$ 4.67	1001.	$ 4675.	14.45	67549.
E. COAL	$ .00	0.	$ 0.	11.21	0.
F. TOTAL		1001.	$ 4675.		$ 67549.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 6495.
(1) DISCOUNT FACTOR (TABLE A) 10.59
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 68782.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 68782.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 22291.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) 8.20
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 11170.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 136331.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 12.44
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 .98

WATER FLOW RESTRICTORS SAMPLE CALCULATION, ECO #8
BUILDING 60

Given:

# of people	= 48 people	-from field survey
Water heater efficiency	= 70%	-assumed
Gas cost	= $4.67 / MBtu	-from utility rate analysis
Water Cost	= $2.39 / 1000 gals	-from utility rate analysis

Showers:

# of showers	= 18 showers	-from field survey
Existing water flow	= 3.75 gpm	-from field survey
Improved water flow	= 1.6 gpm	-from field survey
Usage	= (7 min/person day)*(365 days/year)	
	= 2,555 min/person yr	-assumed
Shower water temperature	= 102°F	-assumed
Supply water temperature	= 66°F	-from City of Atlanta info

Faucets:

# of faucets	= 36 faucets	-from field survey
Existing water flow	= 2.25 gpm	-from field survey
Improved water flow	= 0.40 gpm	-from field survey
Usage	= (5 min/person day)*(365 days/year)	
	= 1,825 min/person yr	-assumed
Faucet water temperature	= 80°F	-assumed
Supply water temperature	= 66°F	-from City of Atlanta info

Annual Existing Flow:

Showers:
(48 people)*(3.75 gpm)*(2,555 min/yr) = 459,900 gal/yr
Faucets:
(48 people)*(2.25 gpm)*(1,825 min/yr) = 197,100 gal/yr
Total:
459,900 gal/yr + 197,100 gal/yr = 657,000 gal/yr

Annual Improved Flow:

Showers:
(48 people)*(1.6 gpm)*(2,555 min/yr) = 196,224 gal/yr
Faucets:
(48 people)*(0.40 gpm)*(1,825 min/yr) = 35,040 gal/yr
Total:
196,224 gal/yr + 35,040 gal/yr = 231,264 gal/yr

Annual Non-Energy Savings:

Showers:
459,900 gal/yr - 196,224 gal/yr = 263,676 gal/yr
Faucets:
197,100 gal/yr - 35,040 gal/yr = 162,060 gal/yr
Total:
657,000 gal/yr - 231,264 gal/yr = 425,736 gal/yr

Annual Energy Savings:

Showers:
(263,676 gal/yr)*(8.33 lbs/gal)*(1 Btu/lb °F)*(102°F - 66°F)/70%
= 113.0 MBtu/yr
Faucets:
(162,060 gal/yr)*(8.33 lbs/gal)*(1 Btu/lb °F)*(80°F - 66°F)/70%
= 27.0 MBtu/yr
Total:
113 MBtu/yr + 27 MBtu/yr = 140 MBtu/yr

Annual Cost Savings

($4.67/MBtu)*(140 MBtu/yr) + ($2.39/1000 gal)*(425,736 gal/yr)
= $1,671/yr

Estimated Construction Cost:

$31.74/shower	-from engineer's cost estimate
$17.36/faucet	-from engineer's cost estimate

($31.74/ea)*(18 showers) + ($17.36/ea)*(36 faucets)
= $1,196

$1,196 + ($1,196 * .055 SIOH) + ($1,196 * .06 DESIGN) = $1,334

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
QRIP PROJECT

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 16-Jul-92
FILE: FNLECO.WK3
PREPARED BY: CMD
CHECKED BY: CEL

	ENERGY COST	25-YR DISCOUNT FACTOR	15-YR DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	23.77 UPWG	14.45 UPWG
Electric Savings	$0.0255 / kWh	15.61 UPWE	11.11 UPWE
Demand Savings	$8.85 / kW	14.53 UPW	10.59 UPW

ECO #	ECONOMIC LIFE (yrs)	ANNUAL/ PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON-ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
ECO-8	15	0	0	1,001	1,001	$4,675	$0	$6,495	$11,170	$10,956	12.4	1.0
TOTAL		0	0	1,001	1,001	$4,675	$0	$6,495	$11,170	$10,956	12.4	1.0

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 8 – Water Flow Restrictors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 17-Jul-92
FILE: ECO-8.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	14.45 UPWG
Electric Savings	$0.0255 / kWh	11.11 UPWE
Demand Savings	$8.85 / kW	10.59 UPW
Water Savings	$2.390 / 1000 gals	10.59 UPW

Economic Life: 15 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON-ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
401	0	0	159	159	$741	$0	$885	$1,627	$425	47.3	0.3
109	0	0	52	52	$244	$0	$448	$692	$238	34.7	0.3
56	0	0	131	131	$611	$0	$803	$1,414	$889	19.5	0.6
58	0	0	131	131	$611	$0	$803	$1,414	$889	19.5	0.6
62	0	0	131	131	$611	$0	$803	$1,414	$889	19.5	0.6
60	0	0	140	140	$654	$0	$1,018	$1,671	$1,334	15.2	0.8
28	0	0	41	41	$191	$0	$298	$488	$445	13.3	0.9
363	0	0	44	44	$204	$0	$244	$449	$425	13.0	0.9
40	0	0	68	68	$319	$0	$476	$795	$934	10.3	1.2
168	0	0	76	76	$354	$0	$499	$853	$1,044	10.0	1.2
27	0	0	29	29	$134	$0	$220	$354	$445	9.6	1.3
									$7,956		
Include $3000 cost for administation of small contract									$3,000		
TOTAL	0	0	790	790	$3,689	$0	$5,162	$8,851	$10,956	9.9	1.2

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 8 – WATER FLOW RESTRICTORS

CLIENT CONTRACT NO: DACA21–9–C–0097
CLIENT PROJECT ENG: TERRY SEABROOK

COST SAVINGS:
WATER $2.390 / 1000 gals

EMC PROJECT: #3105.000
DATE: 22–APR–92
FILE: ECO8.WK3
PREPARED BY: CHRIS STANLEY
CHECKED BY:

		SHOWER FLOW RESTRICTORS									
BLDG #	# PEOPLE	# SHOWERS / BLDG	USAGE / PERSON / YEAR (min/yr)	EXIST FLOW RATE (gpm)	IMPRVD FLOW RATE (gpm)	TOTAL EXIST FLOW (gal/yr)	TOTAL IMPRVD FLOW (gal/yr)	WATER TEMP SHOWER (°F)	WATER TEMP SUPPLY (°F)	# FAUCETS / BLDG	USAGE /PERSON / YEAR (min/yr)
027	20	6	2555	2.50	1.50	127,750	76,650	102	66	12	1,825
028	20	6	2555	3.00	1.50	153,300	76,650	102	66	12	1,825
40	30	16	2555	3.25	1.50	249,113	114,975	102	66	19	1,825
56	32	12	2555	5.00	1.50	408,800	122,640	102	66	24	1,825
58	32	12	2555	5.00	1.50	408,800	122,640	102	66	24	1,825
60	48	18	2555	3.75	1.60	459,900	196,224	102	66	36	1,825
62	32	12	2555	5.00	1.50	408,800	122,640	102	66	24	1,825
109	18	4	2555	3.50	1.75	160,965	80,483	102	66	5	1,825
168	34	18	2555	3.20	1.40	277,984	121,618	102	66	21	1,825
363	20	12	2555	3.75	1.75	191,625	89,425	102	66		
401	40	12	2555	5.63	2.00	574,875	204,400	102	66		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: **8 – WATER FLOW RESTRICTORS**

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 22-APR-92
FILE: ECO8.WK3
PREPARED BY: CHRIS STANLEY
CHECKED BY:

COST SAVINGS:
WATER $2.390 / 1000 gals

FAUCET FLOW RESTRICTORS						SAVINGS				COST		
EXIST FLOW RATE (gpm)	IMPRVD FLOW RATE (gpm)	TOTAL EXIST FLOW (gal/yr)	TOTAL IMPRVD FLOW (gal/yr)	WATER TEMP FAUCET (°F)	WATER TEMP SUPPLY (°F)	WATER HEATER EFF	ANNUAL GAS SAVED (MBtu/yr)	ANNUAL WATER SAVED (gal/yr)	ANNUAL WATER SAVED ($/yr)	SHOWER CONST COST ($/ea)	FAUCET CONST COST ($/ea)	TOTAL CONST COST ($)
2.25	1.13	82,125	41,063	80	66	70%	28.7	92,163	$220	$31.74	$17.36	$399
1.88	0.56	68,438	20,531	80	66	70%	40.8	124,556	$298	$31.74	$17.36	$399
1.75	0.56	95,813	30,797	80	66	70%	68.3	199,153	$476	$31.74	$17.36	$838
1.35	0.50	78,840	29,200	80	66	70%	130.9	335,800	$803	$31.74	$17.36	$798
1.35	0.50	78,840	29,200	80	66	70%	130.9	335,800	$803	$31.74	$17.36	$798
2.25	0.40	197,100	35,040	80	66	70%	140.0	425,736	$1,018	$31.74	$17.36	$1,196
1.35	0.50	78,840	29,200	80	66	70%	130.9	335,800	$803	$31.74	$17.36	$798
3.75	0.50	123,188	16,425	80	66	70%	52.3	187,245	$448	$31.74	$17.36	$214
1.88	1.03	116,344	63,912	80	66	70%	75.7	208,798	$499	$31.74	$17.36	$936
						70%	43.8	102,200	$244	$31.74	$17.36	$381
						70%	158.7	370,475	$885	$31.74	$17.36	$381

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

X CODE A | CODE B | CODE C | OTHER

EFFECTIVE PRICING DATE APR 92

DATE PREPARED 15-Apr-92

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

DRAWING NO.

SHT OF

ESTIMATOR RMG

CHECKED BY

ECO 8 -- Water Flow Restrictors	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
LOW FLOW SHOWER HEAD	1	EA	0.330	0.330	$21.45	$7.08			$15.00	$15.00	$22.08		
SUBTOTAL						$7.08					$22.08		
OVERHEAD, BOND	15%					$1.06					$3.31		
PROFIT	10%					$0.71					$2.21		
COST SUB-TOTAL						$8.85					$27.60		
CONTINGENCY	15%					$1.33					$4.14		
TOTAL						$10.18					$31.74		
LOW FLOW FAUCET	1	EA	0.330	0.330	$21.45	$7.08			$5.00	$5.00	$12.08		
SUBTOTAL						$7.08					$12.08		
OVERHEAD, BOND	15%					$1.06					$1.81		
PROFIT	10%					$0.71					$1.21		
COST SUB-TOTAL						$8.85					$15.10		
CONTINGENCY	15%					$1.33					$2.26		
TOTAL						$10.18					$17.36		

DA FORM 5416-R, APR 85

JOB 3105.000 / ESOS

SHEET NO. ______ OF ______

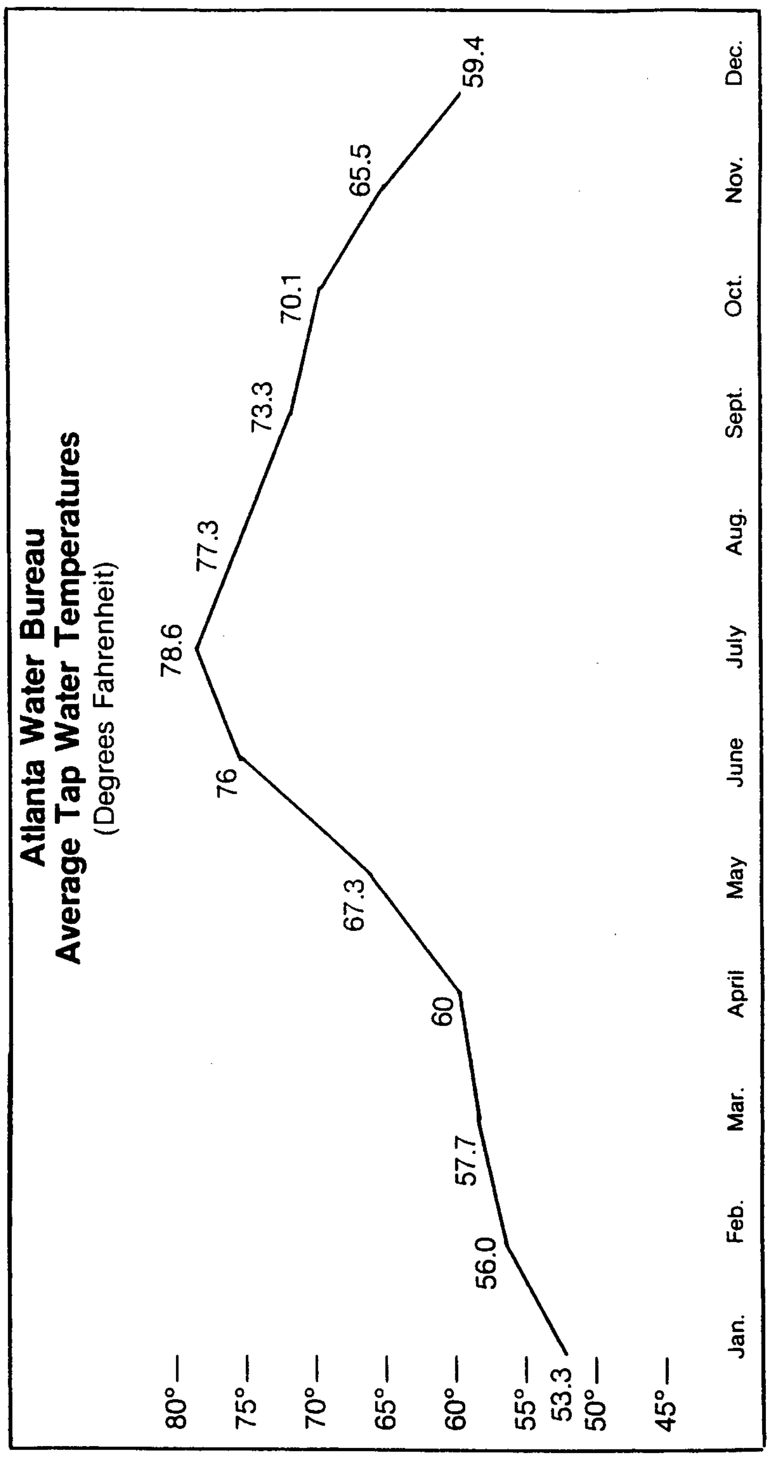
E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • Germany

CALCULATED BY CEL DATE 4/21/92

CHECKED BY ______ DATE ______

SCALE ______



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MEAN = 66 °F

APPENDIX D-3 FAMILY HOUSING PROJECT

ECO-16, ONE-WAY FM RADIO CONTROL OF AIR-CONDITIONING CONDENSING UNITS

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: MPJ1
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: FAMILY HOUSING PROJECT
ANALYSIS DATE: 07-16-92 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	73526.
B. SIOH	$	4044.
C. DESIGN COST	$	4412.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	81982.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	0.	$ 0.	11.11	0.
B. DIST	$ .00	0.	$ 0.	14.26	0.
C. RESID	$ .00	0.	$ 0.	16.89	0.
D. NAT G	$ 4.67	0.	$ 0.	14.45	0.
E. COAL	$ .00	0.	$ 0.	11.21	0.
F. TOTAL		0.	$ 0.		$ 0.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 17966.
(1) DISCOUNT FACTOR (TABLE A) 10.59
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 190260.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 190260.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 0.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) .00
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 17966.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 190260.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 2.32
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 4.56

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
FAMILY HOUSING PROJECT

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 16-Jul-92
FILE: FNLECO.WK3
PREPARED BY: CMD
CHECKED BY: CEL

	ENERGY COST	25-YR DISCOUNT FACTOR	15-YR DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	23.77 UPWG	14.45 UPWG
Electric Savings	$0.0255 / kWh	15.61 UPWE	11.11 UPWE
Demand Savings	$8.85 / kW	14.53 UPW	10.59 UPW

ECO #	ECONOMIC LIFE (yrs)	ANNUAL/ PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON-ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
ECO-16	15	175	0	0	0	$0	$17,966	$0	$17,966	$81,982	2.3	4.6
TOTAL		175	0	0	0	$0	$17,966	$0	$17,966	$81,982	2.3	4.6

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

ECO: **16, INVESTIGATE POST DEMAND**

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #310
DATE: 22-Apr-92
FILE: DEMAND.WK
PREPARED BY:
CHECKED BY:

FT. MC PHERSON TRANE HEAT PUMP SCHEDULE
ENERGY SAVINGS OPPORTUNITY SURVEY – FT. MC PHERSON, GA

BLDG NO.	QTY.	MODEL NO. BWD___100_0	DESCRIPTION	VOLTS EACH	AMPS EACH	TOTAL KW	TONS EACH
1	2	724AB	SPLIT HP	208	30	11	2
1	2	730AB	SPLIT HP	208	40	15	2.5
2	2	724AB	SPLIT HP	208	30	11	2
2	2	730AB	SPLIT HP	208	40	15	2.5
3	2	724AB	SPLIT HP	208	30	11	2
3	2	730AB	SPLIT HP	208	40	15	2.5
4	2	724AB	SPLIT HP	208	30	11	2
4	2	730AB	SPLIT HP	208	40	15	2.5
5	2	742AB	SPLIT HP	208	50	19	3.5
6	2	724AB	SPLIT HP	208	30	11	2
6	2	718AB	SPLIT HP	208	20	7	1.5
7	2	724AB	SPLIT HP	208	30	11	2
7	2	718AB	SPLIT HP	208	20	7	1.5
8	2	724AB	SPLIT HP	208	30	11	2
8	2	718AB	SPLIT HP	208	20	7	1.5
9	2	724AB	SPLIT HP	208	30	11	2
9	2	718AB	SPLIT HP	208	20	7	1.5
10	1	760AA	SPLIT HP	230	60	12	5
10	1	748AA	SPLIT HP	230	50	10	4
11	4	730AB	SPLIT HP	208	40	30	2.5
12	4	730AB	SPLIT HP	208	40	30	2.5
13	4	730AB	SPLIT HP	208	40	30	2.5
14	4	730AB	SPLIT HP	208	40	30	2.5
15	2	730AB	SPLIT HP	208	40	15	2.5
15	2	724AB	SPLIT HP	208	30	11	2
17	4	730AB	SPLIT HP	208	40	30	2.5
18	1	BWX736B100A0	SPLIT HP	230	30	6	3
18	1	724AB	SPLIT HP	208	30	6	2
19	4	730AB	SPLIT HP	208	40	30	2.5
20	1	BWX736B100A0	SPLIT HP	230	30	6	3
20	1	742BA	SPLIT HP	208	50	9	3.5
136	1	BWX736B100A0	SPLIT HP	230	30	6	3
137	1	730AB	SPLIT HP	208	40	7	2.5
138	1	730AB	SPLIT HP	208	40	7	2.5

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

ECO: **16, INVESTIGATE POST DEMAND**

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #310
DATE: 22-Apr-92
FILE: DEMAND.WK
PREPARED BY:
CHECKED BY:

FT. MC PHERSON TRANE HEAT PUMP SCHEDULE
ENERGY SAVINGS OPPORTUNITY SURVEY – FT. MC PHERSON, GA

BLDG NO.	QTY.	MODEL NO. BWD___100_0	DESCRIPTION	VOLTS EACH	AMPS EACH	TOTAL KW	TONS EACH
139	1	730AB	SPLIT HP	208	40	7	2.5
140	1	730AB	SPLIT HP	208	40	7	2.5
141	1	730AB	SPLIT HP	208	40	7	2.5
142	1	730AB	SPLIT HP	208	40	7	2.5
409	8	724AB	SPLIT HP	208	30	45	2
410	8	724AB	SPLIT HP	208	30	45	2
506	2	730AB	SPLIT HP	208	40	15	2.5
507	2	730AB	SPLIT HP	208	40	15	2.5
508	2	730AB	SPLIT HP	208	40	15	2.5
509	2	730AB	SPLIT HP	208	40	15	2.5
510	2	730AB	SPLIT HP	208	40	15	2.5
515	2	730AB	SPLIT HP	208	40	15	2.5
523	2	730AB	SPLIT HP	208	40	15	2.5
524	2	730AB	SPLIT HP	208	40	15	2.5
526	2	730AB	SPLIT HP	208	40	15	2.5
527	2	730AB	SPLIT HP	208	40	15	2.5
528	2	730AB	SPLIT HP	208	40	15	2.5
532	1	BWX736B100A0	SPLIT HP	230	30	6	3
533	2	730AB	SPLIT HP	208	40	15	2.5
534	2	730AB	SPLIT HP	208	40	15	2.5
535	2	730AB	SPLIT HP	208	40	15	2.5
536	2	730AB	SPLIT HP	208	40	15	2.5
537	2	730AB	SPLIT HP	208	40	15	2.5
538	2	730AB	SPLIT HP	208	40	15	2.5
601	2	730AB	SPLIT HP	208	40	15	2.5
602	2	730AB	SPLIT HP	208	40	15	2.5
603	2	730AB	SPLIT HP	208	40	15	2.5
604	2	730AB	SPLIT HP	208	40	15	2.5
605	2	730AB	SPLIT HP	208	40	15	2.5
TOTAL	108					751	

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

[X] CODE A [ ] CODE B [ ] CODE C [ ] OTHER

EFFECTIVE PRICING DATE APR 92

DATE PREPARED 23-Apr-92

DRAWING NO.

SHT OF

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

ESTIMATOR RMG

CHECKED BY CEL

	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
FM RADIO CONTROL UCS TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
BASE COMPUTER w/ SOFTWARE	1	EA	8	8	$21.17	$169.36			$25,000.00	$25,000.00	$25,169.36		
TRANSMITTER, ANTENNA	1	EA	16	16	$21.17	$2,950.00			$12,000.00	$3,650.00	$6,600.00		
PROGRAMMING	25	EA				$150.00					$150.00		
TRAINING, START-UP	1	LS				$5,000.00					$5,000.00		
RADIO SWITCHES	108	EA	1.5	162	$21.17	$3,429.54			$100.00	$10,800.00	$14,229.54		
SUBTOTAL						$11,698.90				$39,450.00	$51,148.90		
OVERHEAD, BOND	15%					$1,754.84				$5,917.50	$7,672.34		
PROFIT	10%					$1,169.89				$3,945.00	$5,114.89		
COST SUB-TOTAL						$14,623.63				$49,312.50	$63,936.13		
CONTINGENCY	15%					$2,193.54				$7,396.88	$9,590.42		
TOTAL						$16,817.17				$56,709.38	$73,526.54		

DA FORM 5416-R, APR 85

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • Germany

JOB Fort McPherson/Fort Gillem ESOS Study

SHEET NO EMC #3105-000 OF

CALCULATED BY CEL DATE

CHECKED BY DATE

SCALE

1) RADIO CONTROL FAMILY HOUSING AC UNITS

-108 AC units
-751 KW load
-Estimate off for 7 minutes every 30 minutes, (7/30) = .23 load shed.
-751 KW * .23 = 175 KW
-Cost $73,527
-Cost per KW, $73,527/175 KW = $420

2) THERMAL STORAGE, BLDG. 200

-750 ton load, est 487 KW
-With pumps, tower, etc. 673 KW
-Cost $1,044,893
-Cost per KW, $1,044,893/673 = $155

3) GAS DRIVEN CHILLER

-460 ton load, est 300 KW
-Cost $400,230
-Cost per KW, $400,230/300 = $134

4) LIGHTING CONTROL

-Control 310 watts of light
(2, 4'x 2', 4 tube fluorescent)
-1 wall switch, $65.11
-Cost per KW, $65.11/.31 = $210

Scientific
Atlanta

Control Systems Division – Box 105038, Atlanta GA 30348, Telephone 404 441-4000, TWX 810-766 4912; Telex 0542898, ITT 4611081

April 17, 1992

Mr. Carl Lunstrom
EMC Engineers, Inc.
1950 Spectrum Circle
Suite B-312
Marietta, GA 30067

Dear Carl:

I apologize for the delay in sending you the information you requested recently. We do appreciate your interest in our products, and I really do try to give faster attention to inquiries such as yours. As we discussed, Scientific-Atlanta is a leading manufacturer of radio operated load management systems.

I am enclosing several data sheets to describe a system which would be suitable for Fort McPherson. We can offer a turn-key service to provide and install the head-end equipment, including the transmitter, as well as provide technical support in arranging for installation of the radio switches, which we call DCUs (Digital Control Units). As you know, most military bases would prefer to farm out the labor for installation of these systems.

Budgetary pricing is as follows:

LMC-1041+ Load Management Controller:	$25,000.00
Transmitter and Xtr Controller:	$10,000.00
DCU Radio Switches:	$ 100.00 ea.
Start up and training:	$ 4,000.00
Portable Test Unit:	$ 495.00

I will ask Dick Preston, the regional sales manager for this area, to contact you and provide any further information you may desire. Thanks again for your interest in our products.

Yours truly,

Burns Porter

G. Burns Porter
Applications Engineering Manager

GBP/sjb

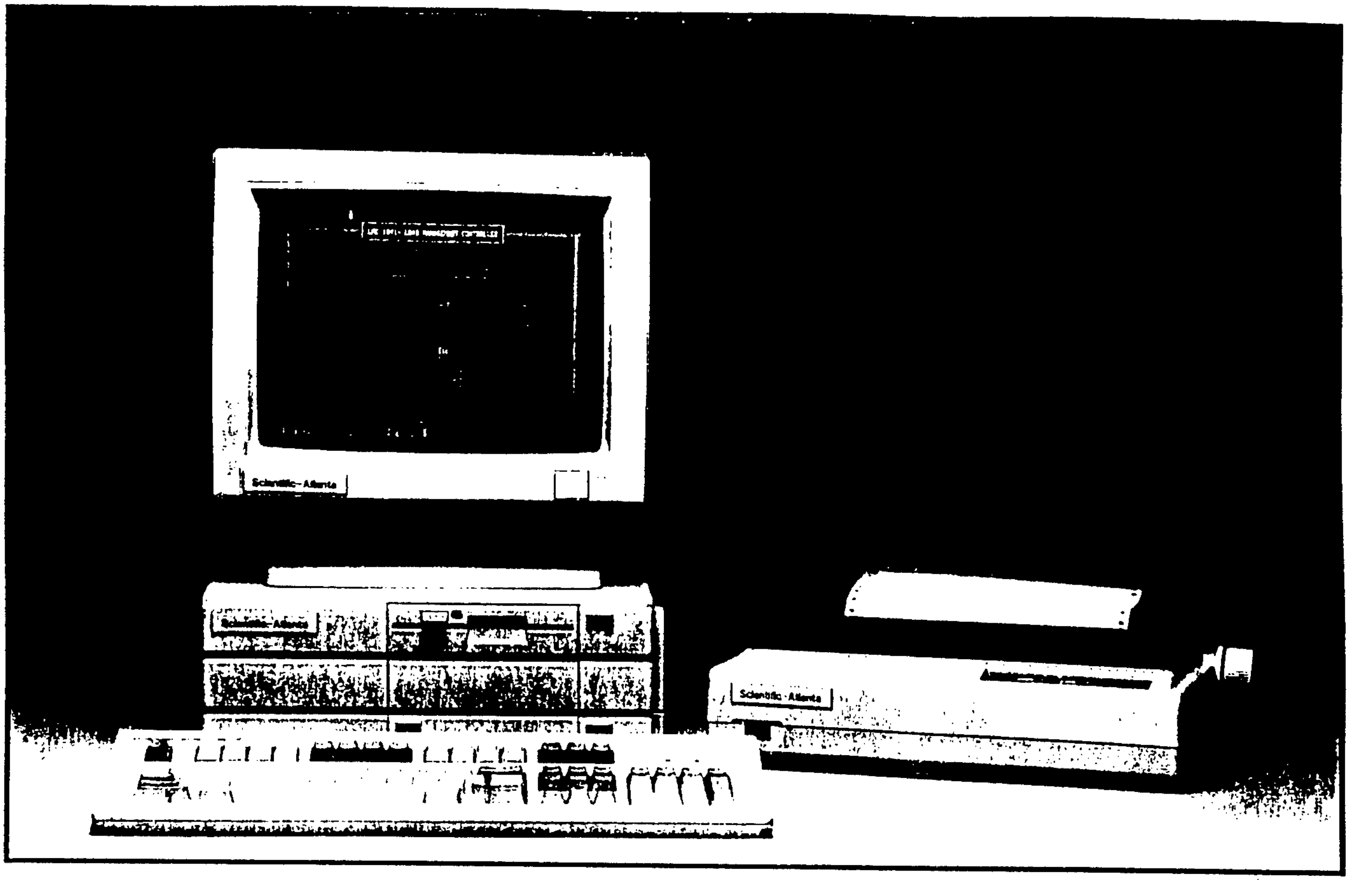
Enclosures

cc: Dick Preston

Scientific Atlanta

Control Systems Division

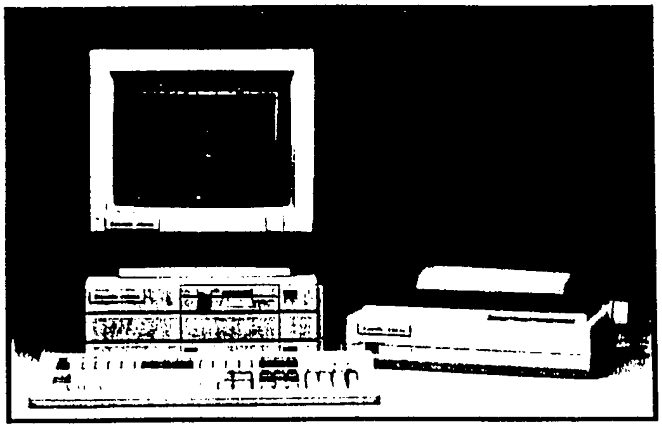
Load Management Controller
Model LMC-1041+



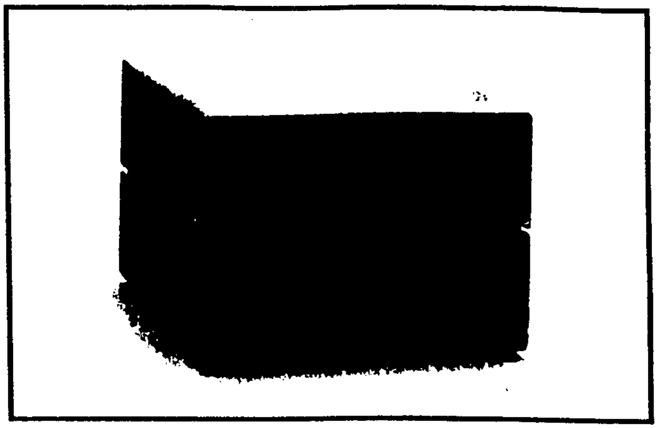
Features

- Combines data acquisition and load control into one machine operating on MS-DOS
- Manual or automatic initiation of load control
- Several load control algorithms are available to the user
- Generates messages in several formats of radio controlled switches
- Program is simple, yet flexible
- Controls air conditioners, water heaters, irrigation pumps, and capacitor banks
- User can define the control "steps" that the program uses
- All programming is done with pop-up menus and operator prompts with on-screen helps
- User defines the number of addresses, number of control groups and strategies he wants and the LMC creates file space to accommodate, limited only by available memory
- Operating characteristics can be modified while the program is running
- Special screens can easily be designed and implemented by the user
- Software supports an optional color monitor
- All software is stored on a hard disk
- Lotus®- compatible historical data files allow easy processing of accumulated data
- Printer can be programmed to automatically print reports
- System automatically restarts in case of power outage
- Interfaces to Scientific-Atlanta's Remote Transmitter Controllers RTC-1032 or RCCA-1002A
- Optional WWV interface ensures accurate timekeeping
- Software supports bar chart and line graphics

Model ***LMC-1041+*** Load Management Controller



LMC 1041+, Load Management Controller



RTC-1032, Remote Transmitter Controller

Description

The LMC-1041+ is a personal computer based load management controller and data acquisition system. Automatic or manual control commands are initiated by the LMC-1041+ to remotely installed radio receivers. The receivers control loads such as air conditioners, water heaters, pool pumps, irrigation pumps, etc. Power factor control is also possible by remotely controlling distribution feeder capacitor banks.

Data acquisition capabilities of the LMC-1041+ permit monitoring of substation data for display and/or initiation of automatic control functions. Automatic control can be done using kW or kVAR inputs, status point closures, and/or time-of-day and day-of-week schedules.

Capable of outputting all standard Scientific-Atlanta code formats as well as a number of others, the LMC-1041+'s flexible software permits the user to easily configure the system by selecting the options he wants from the pop-up menus, lists of valid entries, and notes which briefly explain what each entry does.

An unlimited number of load groups as well as multiple load control algorithms, time-of-day schedules and control strategies provide ultimate flexibility. The user can even modify existing displays or create new displays to meet his needs using the LMC-1041+ display editor. With this capability he can display the most important "real-time" and explanatory information.

The LMC-1041+ places no limit on the number of strategies, load groups, or switch addresses the utility may use. The user tells the LMC what he wants to do and the LMC creates file space to meet the user's needs. The only limit is the amount of memory available.

The LMC-1041+ program is organized by strategies, setpoints, status points and time-of-day schedules. The user can then apply these characteristics to increase or decrease the amount and type of load to be shed and restored to meet changing control requirements. The user can call for load control algorithms such as cycling at a designated percentage, on/off control, various distributed intelligence strategies, nicking or SCRAM. These can be used in virtually any combination to meet the user's control needs.

The LMC-1041+ also has several features which support the user in operating the system and reporting what has happened. All information can be formatted into a Lotus® compatible file and stored on the hard disk. The printer can be programmed to print out any or all events such as alarms or the automatic initiation of load control.

The LMC-1041+ also uses Scientific-Atlanta's Remote Transmitter Controller (RTC-1032) in this system. An RTC-1032 is located at each transmitter site, connected to the LMC through 1200 baud modems. The RTC-1032 (formerly the RCCA-1002A) receives the messages to be broadcast from the LMC, stores those messages until its proper time slot, keys the transmitter, then generates the proper modulation (tones or shifting frequency) to represent the message.

The RTC can generate most of the formats used in load control today. These include single tone, two tone, Scientific-Atlanta's digital, 100, 102, SA-105 and SA-205 AFSK formats, and the Golay 23, 12 FSK format.

The RTC can control up to six groups of transmitters (for time slot coordination with other utilities). If a carrier-operated relay is in the transmitter, the RTC can also wait until the air clears before broadcasting.

The LMC-1041+ is typically quoted with the standard hardware shown in the specifications section. The RTC's and modems are quoted separately because each system may require different numbers of transmitters.

Specifications

LMC-1041+ Hardware

- Personal computer running on MS-DOS operating system with enhanced keyboard and 640K of RAM
- 13" Color Monitor
- 3 1/2" 720K floppy disk drive
- 20 MB hard disk
- Dot matrix printer
- Serial port
- Parallel port
- Data acquisition board and connector panel with 8 analog inputs, 8 status inputs, and 8 contacts out
- All interfaces and cables required
- Hardware Options:
  1. Up to 24 analog inputs, 24 status inputs, and 24 contacts out

LMC-1041+ Software

- **Load control**

1. Strategies

a. Up to 1000 allowed
b. One or more running at the same time
c. Up to 100 load control steps per strategy
d. Direction of the steps can be changed whether in shed or restore mode
e. Strategies can be tied to any combination of four status points, analog demands, or time-of-day schedules for automatic initiation of load control
f. And/or conditionals enhance initiation factors
g. Strategy activation can be automatic (tied to activation parameters), continuous (constantly active), or in SCRAM mode (to select 100% shed of all points)

2. Steps

a. Three types of steps (activation of switch groups, closing control points, or resetting strategy activation level to a new point)
b. Automatic, continuous, or SCRAM activation of any step
c. Steps can be linked to make them happen at the same time in either the shed or restore direction.
d. Information going to the historical data files can be turned on and off

3. Switch Group Steps

a. Switch control algorithms
   - Sequential step (on/off in the same order each time)
   - Rotational step (on/off in rotating order)
   - Gradual time cycle (achieve designated % over one time-out period)
   - Fast time cycle (achieve designated % in one burst of messages)
   - Target % load shed (responds to changes in demand level)
   - Nicking (for testing the effectiveness of load control)
   - 102 commands (repeating direct load control)
   - SA-105 and SA-205 commands (distributed intelligence control)

b. Maximum load shed % for this switch group
c. Maximum duration of load control for the switch group
d. Time that the appliance must remain on after reaching its maximum duration before it can be controlled again
e. Time-out, cycle time and number of repetitions selections in the 102, SA-105 and SA-205 format switches.

4. Switch Groups

a. Up to 1000 addresses per group
b. Group assigned to a single or all transmitters
c. Repeat number of messages sent each time (1 or more)
d. Minimum, nominal, and virtual time-outs

5. Addresses

a. Individual addresses can be enabled or disabled
b. Messages sent can be recorded in a data file
c. Nine different formats are supported (SA timeout, SA set/reset, single tone, two tone, Golay, 100, 102, SA-105 and SA-205)

6. Time-of-Day Schedules

a. Schedule name
b. Programmed for seven days plus holidays
c. 4 start/stop intervals per day

7. Holiday Lists

a. 20 days

8. Transmit Schedule and System Options

a. Enable or disable transmissions during each minute of the hour (for coordination with other utilities)
b. Time slotting for 1 to 6 transmitter groups (divides the minute into 10 to 60 second time slots)
c. Carrier busy "listen-before-talk"
d. Password security
e. WWV time synchronization

Typical Load Management Program

Control: Can be enabled or disabled from this page

Mode: Allows automatic or manual operation.

Status: Shows whether control is active or inactive.

Status: Indicates current load control activity (shedding or restoring).

A: The demand level at which load control is initiated.

B: The demand level at which the program starts restoring the loads.

This screen was "built" by the user from standard information to display the most important information on a real-time basis.

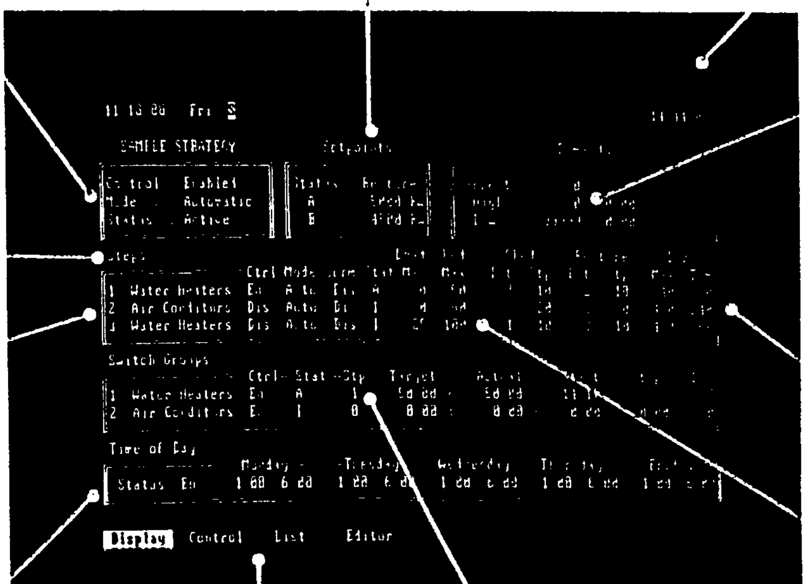
Current: Total system demand

High: The high demand (with time) for the current period.

Low: The low demand for the current period.

Steps: Define the order of the procedure for controlling load.

Names: The type of load controlled in each step.



Duration: The maximum and current duration of this step being active.

Load Shed–Min and Max: Sets the limits of load shed percentage for this step.

Time of Day: Shows which days and what time of day this strategy can be active (subject to other setpoint demands and/or contact closures).

Main Menu: This can be displayed on any page in the run mode by hitting the (ESC) key.

Step: Describes in which step this switch group is currently being used.

Specifications (Cont.)

- ### Data Acquisition

  1. ***Remote Terminals***
     a. Individually addressable
     b. Polling can be enabled or disabled
     c. Polling interval in one minute increments
     d. Up to 24 status points
     e. Up to 24 analog-in points
  2. ***Telemetry (analog inputs)***
     a Default values can be assigned in case of communication failures
     b. Scaling mulitipliers are used
     c. Offsets establish starting points
     d. High and low limits establish use of defaults
  3. ***Calculate***
     a. Analog values used to calculate demands
     b. Unlimited number of calculations available
     c. 30 different operators can be used
  4. ***Demands***
     a. Names
     b. Unlimited number
     c. Combines analog inputs in any manner
     d. Demand interval set from 1 to 60 minutes
  5. ***Setpoints***
     a. User designated initiation factors (kW, kVAR, kVA, temperature, etc.)
     b. User sets shed and restore values
     c. User decides the relationship of the shed and restore values
  6. ***Control Points***
     a. Name
     b. Up to 24 contacts-out (external)
     c. Unlimited number of internal control points

- ### Reporting

  1. ***Printer***
     a. Automatic printing of events (alarms and actions)
     b. Automatic printout of special screens at designated times
  2. ***Display building program***
     a. Used to develop special, custom-built screens
  3. ***Historical Data Files***
     a. Name
     b. Captures designated display numbers
     c. Establish interval between captures
     d. Establish file sizes
     e. Reset data by day of the month
  4. ***Graphics***
     a. Explanatory including lines and boxes
     b. Real time bar and line graphs
     c. User choice of colors, intensity, axes and offsets
  5. ***Transmitter Check-Back***
     a. Error indications from the transmitter sites can alarm at the LMC

- ### Miscellaneous

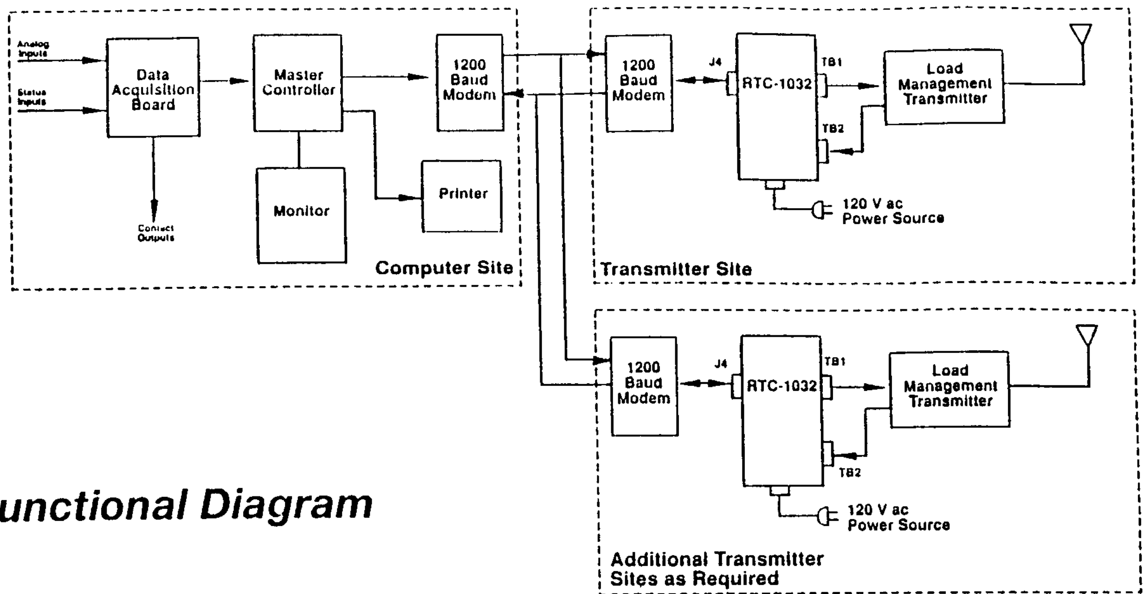
  1. Pop-up bar type menus
  2. On-screen programmable helps (lists options at each choice)
  3. Programming is done by filling in the blanks
  4. Function keys (F1 - F12) are user programmed to enact control or call up screens
  5. A majority of programming characteristics can be changed while the program is running
  6. Copy configurations to floppy disk
  7. Automatic testing for illegal parameters and relationships
  8. Redundant hardware configuration allows automatic transfer between machines in case of failure

- ### Options

  - Communications package to allow a remote computer to query, modify the program, or enact control

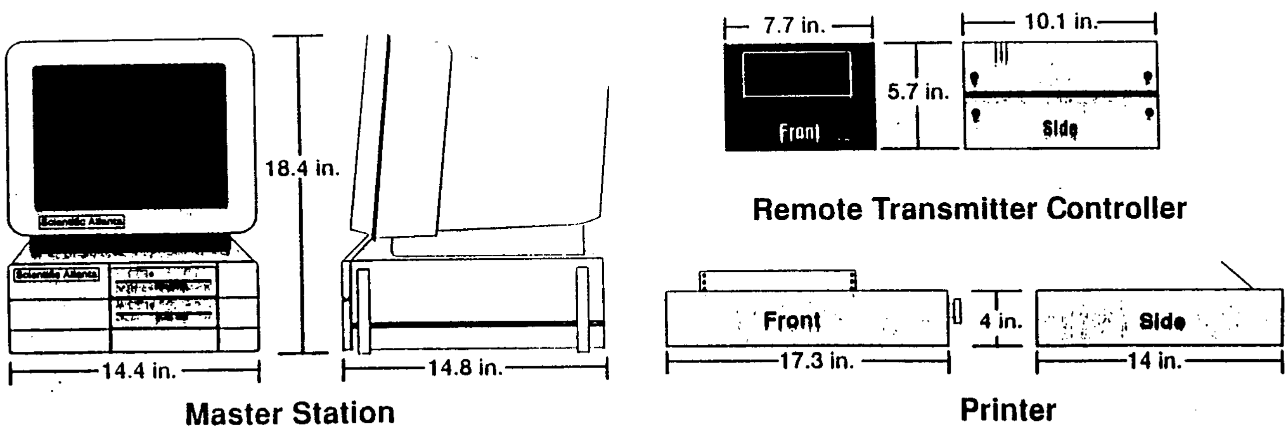
RTC-1032 Remote Transmitter Controller

- Input - 120V ac, 60 Hz
- Power Consumption - 30 watts
- Operating temperature 0°C - +50°C
- Control Output - 6 SPST contacts, 250V ac, 3A
- Communications Modem - 1200 baud, bell 212
- Listen-before-talk - contact closure from carrier operated relay in the transmitter with LBT override (if the channel stays busy)
- Status Input - two contact closures



Functional Diagram

Component Outline Dimensions



Scientific-Atlanta, Inc.

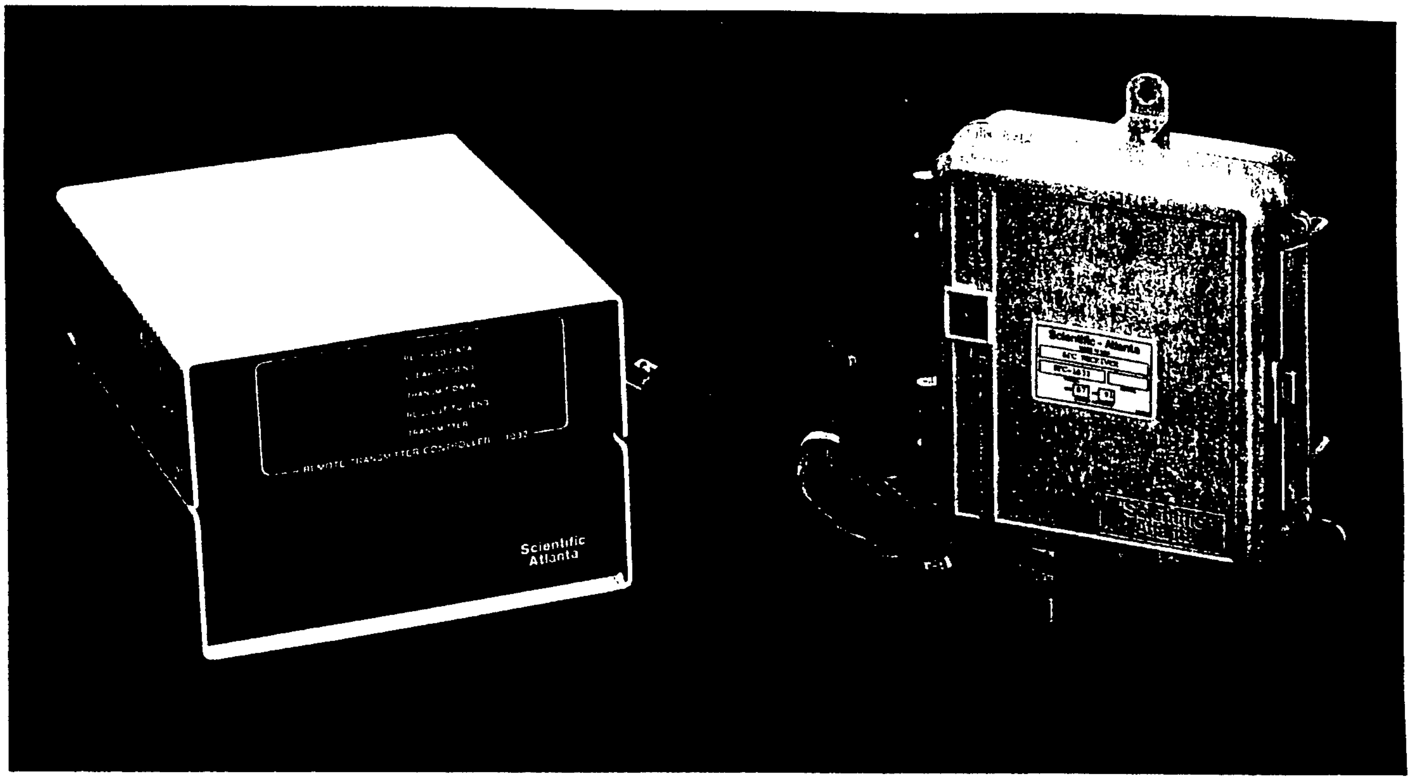
"Our Customers are the winners."

404-449-2900

United States: 4300 Northeast Expressway, Atlanta, GA 30340; FAX 404-449-2931; Telex 0542898

Scientific Atlanta
Instrumentation Group

Transmitter Controllers
Model RTC-1032/SFC-1033



20118

Generates audio messages received from a master controller to activate load management switches for demand control.

Features

- Multiple transmitter control (up to six)
- Capable of seven different VHF message formats
- "Listen-before-talk" option
- Watchdog circuitry
- Power fail detect circuit

Applications

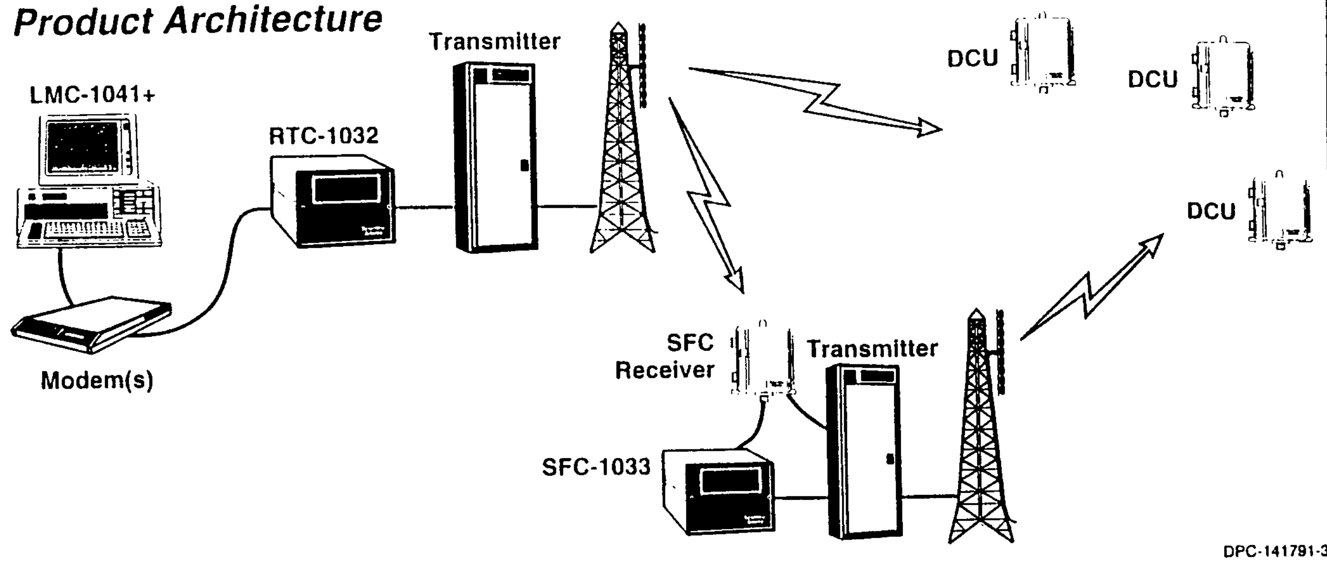
The RTC-1032 Remote Transmitter Controller is capable of generating messages in any of seven code formats to activate load management switches based on data downloaded from a master controller.

The SFC-1033 Store and Forward Controller is identical to the RTC-1032 and is located adjacent to a repeater. The SFC repeats data it has received via the antenna switch relay circuit located in the repeater.

Scientific-Atlanta, Inc.
404-449-2900

Transmitter Controllers
Model RTC-1032/SFC-1033

Product Architecture



Operation

The RTC-1032 receives load control messages and timing messages from a master controller. The RTC-1032 then generates audio tones representing digital messages and keys the transmitter at the appropriate times. The RTC-1032 is capable of receiving and responding to a contact closure for "listen-before-talk" to make sure the channel is free before transmitting. The RTC-1032 contains watchdog circuitry to eliminate lockups of microprocessors caused by transients and power surges.

Two modes of transmissions are provided when using multiple transmitter control. The "slotted mode" divides the minute into as many as six time slots, so that each RTC-1032 keys each transmitter at the appropriate interval. Where a single RTC-1032 is connected to multiple transmitters, the "contiguous mode" keys the transmitters back-to-back with only key up/key down delays between transmissions.

The SFC-1033 receives load control messages and timing messages via the antenna switch relay circuit located in the repeater. The SFC-1033 buffers the data and retransmits it, acting just like the RTC-1032. The SFC-1033 will generate the digital messages and key the transmitter/repeater at the appropriate times. The SFC-1033 can respond to a contact closure for "listen-before-talk" to make sure the channel is clear before transmitting. The SFC-1033 also contains the watchdog circuitry.

The SFC-1033 can control multiple transmitters located at a central remote location by tieing into just one of the receivers. Several SFC-1033s can be used within a system but one RTC-1032 is required at the main transmitter.

The RTC/SFC can generate the following formats:

Single-tone	Two tone sequential
SA Digital	Golay 23.12d
REMS 100/102	SA-105
SA-205	

Specifications

Enclosure
Aluminum
Size
7.7 in. W x 5.7 in. H x 9.1 in. D
Weight
8.5 lbs.
Shipping weight
10 lbs
Input voltage
120V ac, ±10%, 60 Hz
Power consumption
30W max
Operating temperature
0°C to 50°C, non-condensing
Transmittal keying control
6 "SPST" - Normally opened relays rated at
.5A 125V ac
.6A 110V dc

Specifications subject to change without notice

Ordering Information

RTC-1032	Remote Transmitter Controller
SFC-1033	Store and Forward Controller

Scientific-Atlanta, Inc.

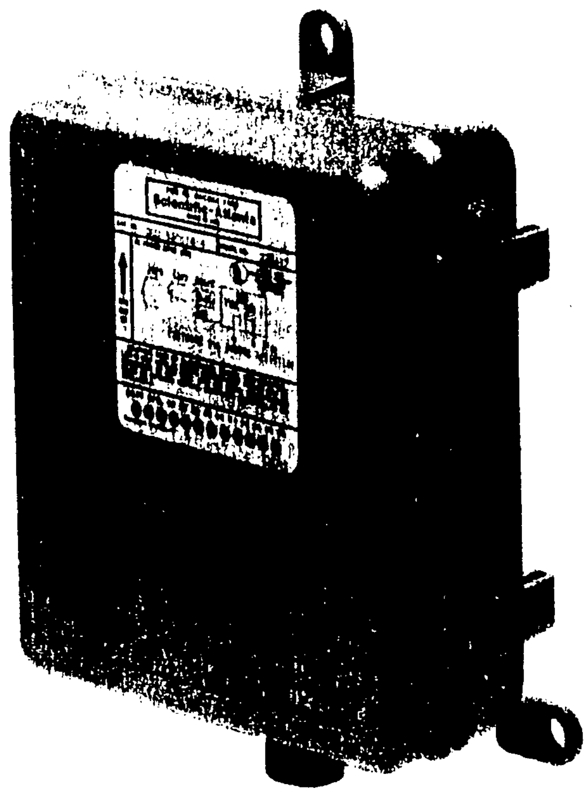
Our customers are the winners.

4300 Northeast Expressway, Atlanta, GA 30340 Tel: 404-449-2900 Fax: 404-449-2931

Scientific Atlanta

Control Systems Division

Digital Control Unit
Series DCU-S2000A



The radio controlled switch interrupts loads, such as air conditioners, water heaters and irrigation pumps, upon command from the utility's master controller for load management.

Features

- 4 million individual fixed addresses
- 6 programmable operational addresses per switch can be grouped for divisional, area, substation or feeder control
- Remote programming via radio message
- Choose from 4,096 programmable, operational addresses
- Distributed intelligence design provides up to 8 hours of control with one message
- Randomized "shed" and "restore" provide smooth, graceful ramping in and out of load control
- High performance dual conversion FM receiver
- Cold load pickup and cancel
- A record of actions kept in non-volatile memory, accessible by the Portable Counter Display®
- Fail safe timer reconnects load at the end of the control period
- Weatherproof, Lexan® enclosure
- Electronics mounted in removable door for easy field maintenance
- One, two, three or four separate functions

Description

The SA-205 format Digital Control Unit (DCU) is a radio controlled switch designed to switch remote loads on and off in response to commands from a central control. Additionally, each digital control unit may be individually programmed and controlled remotely via radio signals.

Utilizing "distributed intelligence", control for up to eight hours can be accomplished upon the receipt of a single radio command. A smooth transition into as well as out of control is ensured through the use of a unique, linear control algorithm in which each switch independently selects its own start and stop times after receipt of a radio control message.

SA-205 Digital Control Units are available in one, two, three or four function designs. Cold load pickup, a feature which disconnects load when power is restored after an outage, is remotely programmable from 0 to 60 minutes via radio message.

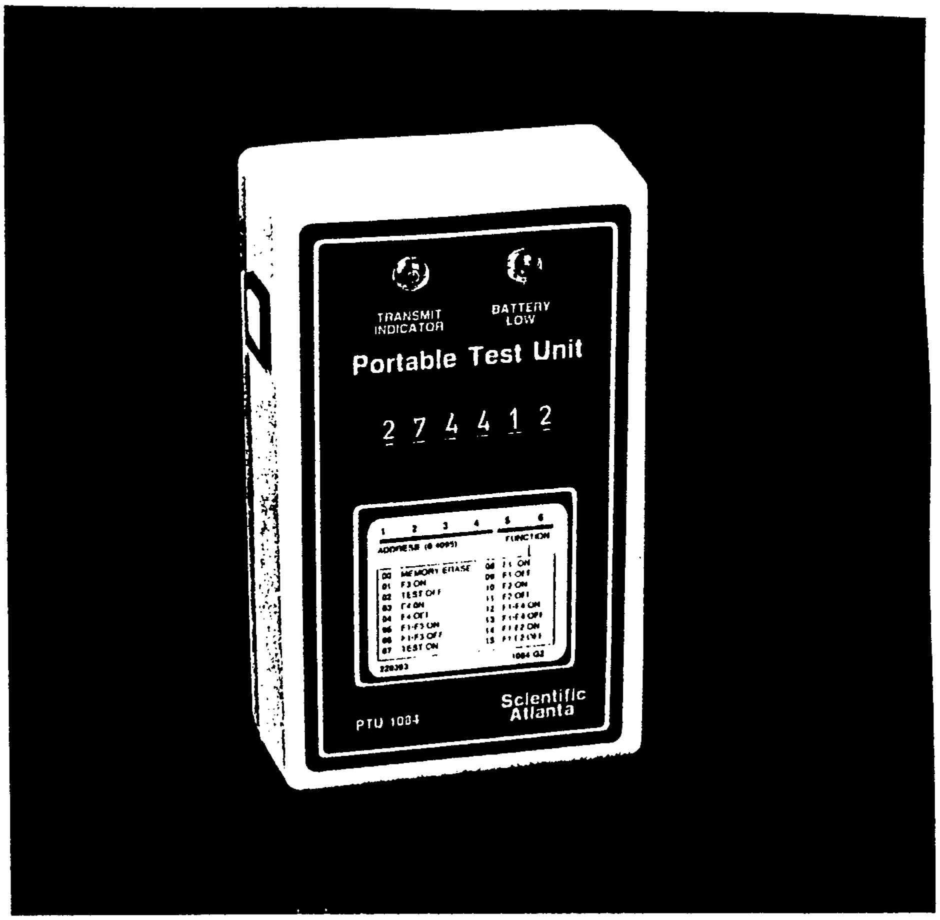
Important data about the DCU's operation, including the number of operations, time since its memory was reset and configuration data, is maintained in the unit's memory. Data can be read with a Scientific-Atlanta Portable Counter Display (PCD), without opening the DCU door. The Portable Counter Display transmits a radio signal to the digital control unit which causes the DCU to flash its LEDs in a digital manner. The PCD optically reads the data and displays it on a liquid crystal display.

Scientific Atlanta

Instrumentation Group

Portable Test Unit
Model PTU-1084/1085

A hand-held device that locally exercises the functionality of a Digital Control Unit.



19921

Features

- Provides on-site testing of radio controlled switches
- Available for use with popular FSK and AFSK code formats
- Powered by replaceable 9V battery
- Low battery indicator
- Includes nylon case

Application

Scientific-Atlanta's PTU-1084/1085 Portable Test Unit is a hand-held, battery operated low output transmitter which permits field testing of Digital Control Units. It allows manual transmission of digital radio signals to test for proper operation of a switch. The economy and portability of the PTU make it practical for each switch to be tested as it is installed.

The PTU-1084/1085 is crystal-controlled and transmits on a customer-specified VHF frequency, between 138 and 174 MHz.

Scientific-Atlanta, Inc.

404-449-2900

APPENDIX D-4 NAF PROJECTS

ECO-1, ADD PIPE INSULATION
ECO-1, ADD ROOF INSULATION
ECO-1, ADD DUCT INSULATION
ECO-7 CONTROL HOT WATER CIRCULATION PUMPS
ECO-12, REVISE OR REPAIR HVAC CONTROLS

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: MNAF
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON,REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: NAF PROJECTS
ANALYSIS DATE: 07-17-92 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	54143.
B. SIOH	$	2978.
C. DESIGN COST	$	3249.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	60370.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	709.	$ 5297.	11.11	58852.
B. DIST	$ .00	0.	$ 0.	14.26	0.
C. RESID	$ .00	0.	$ 0.	16.89	0.
D. NAT G	$ 4.67	1486.	$ 6940.	14.45	100278.
E. COAL	$ .00	0.	$ 0.	11.21	0.
F. TOTAL		2195.	$ 12237.		$ 159130.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 411.
(1) DISCOUNT FACTOR (TABLE A) 10.59
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 4352.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 4352.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 52513.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 12648.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 163482.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 2.71
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 4.77

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

NAF PROJECTS

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 21-Jul-92
FILE: FNLNAF.WK3
PREPARED BY: CMD
CHECKED BY: CEL

	ENERGY COST	25-YR DISCOUNT FACTOR	15-YR DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	23.77 UPWG	14.45 UPWG
Electric Savings	$0.0255 / kWh	15.61 UPWE	11.11 UPWE
Demand Savings	$8.85 / kW	14.53 UPW	10.59 UPW

PROJECT ECONOMIC LIFE 15 YEARS

ECO #	ECONOMIC LIFE (yrs)	BUILDING NUMBER	ANNUAL/ PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON-ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
ECO-1P	25	155	0	0	654	654	$3,052	$0	$0	$3,052	$3,364	21.6	1.1
ECO-1P	25	360	0	4	41	41	$193	$0	$0	$193	$303	15.1	1.6
TOTAL ECO-1	25		0	4	695	695	$3,245	$0	$0	$3,245	$3,667	21.0	1.1
ECO-7	15	500	0	33,679	378	493	$2,624	$0	$0	$2,624	$11,003	3.2	4.2
ECO-12	15	500	4	173,997	413	1,006	$6,366	$411	$0	$6,776	$45,699	1.8	6.7
TOTAL			4	207,680	1,486	2,194	$12,235	$411	$0	$12,645	$60,369	2.7	4.8

SEE APPENDIX C FOR ADDITIONAL BACKUP CALCULATIONS.

APPENDIX D-5, OTHER ENERGY PROJECTS

ECO-3, WEATHERSTRIPPING AND CAULKING
ECO-5, INSTALL HIGH EFFICIENCY ELECTRIC MOTORS
ECO-15, SEPARATE (AUTOMATIC) LIGHT SWITCHES

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: MPJ2
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: OTHER ENERGY PROJECT
ANALYSIS DATE: 07-16-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	172775.
B. SIOH	$	9503.
C. DESIGN COST	$	10367.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	192645.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	1063.	$ 7941.	15.61	123953.
B. DIST	$ .00	0.	$ 0.	21.66	0.
C. RESID	$ .00	0.	$ 0.	26.51	0.
D. NAT G	$ 4.67	-24.	$ -112.	23.77	-2664.
E. COAL	$ .00	0.	$ 0.	16.06	0.
F. TOTAL		1039.	$ 7829.		$ 121289.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 7196.
(1) DISCOUNT FACTOR (TABLE A) 14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 104558.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 104558.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 40025.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) .84
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 15025.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 225847.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.17
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 12.82

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

OTHER ENERGY PROJECTS

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 21-Jul-92
FILE: FNLECO.WK3
PREPARED BY: CMD
CHECKED BY: CEL

	ENERGY COST	25-YR DISCOUNT FACTOR	15-YR DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	23.77 UPWG	14.45 UPWG
Electric Savings	$0.0255 / kWh	15.61 UPWE	11.11 UPWE
Demand Savings	$8.85 / kW	14.53 UPW	10.59 UPW

PROJECT ECONOMIC LIFE 25 YEARS

ECO #	ECONOMIC LIFE (yrs)	ANNUAL/ PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON-ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
ECO-3	25	2	22	1	1	$5	$234	$0	$240	$1,485	2.4	6.2
ECO-5	25	54	264,518	0	902	$6,745	$5,594	$0	$12,339	$162,986	1.1	13.2
ECO-15	25	13	46,857	(25)	135	$1,077	$1,368	$0	$2,445	$28,173	1.3	11.5
TOTAL		69	311,397	(24)	1,039	$7,828	$7,196	$0	$15,024	$192,644	1.2	12.8

ECO-3, WEATHERSTRIPPING AND CAULKING

LIFE CYCLE COST ANALYSIS SUMMARY   STUDY: MECO25
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)   LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-3 WEATHER STRIPPING & CULK
ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	1332.
B. SIOH	$	74.
C. DESIGN COST	$	80.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	1486.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	0.	$ 1.	15.61	9.
B. DIST	$ .00	0.	$ 0.	21.66	0.
C. RESID	$ .00	0.	$ 0.	26.51	0.
D. NAT G	$ 4.67	1.	$ 5.	23.77	111.
E. COAL	$ .00	0.	$ 0.	16.06	0.
F. TOTAL		1.	$ 5.		$ 120.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 234.
(1) DISCOUNT FACTOR (TABLE A) 14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 3400.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 3400.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 40.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) .11
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 239.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 3520.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 2.37
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 6.21

WEATHERSTRIPPING & CAULKING SAMPLE CALCULATION, ECO #3
BUILDING 111

Given:

Stack coefficient(A)	= 0.016	-from ASHRAE Table F 23.7
Wind coefficient(B)	= 0.0039	-from ASHRAE Table F 23.7
Avg. temperature diff.	= 72 - 55 = 17°F	-from Atlanta weather data
Avg. wind speed	= 12.65 mph	-from Atlanta weather data
# of windows	= 24 windows	-from bldg plans / survey notes
Window area	= 380 ft^2	-from bldg plans / survey notes
Exist. window leakage coef.	= 0.052 in^2/ft^2	-from ASHRAE Table F 23.3
Exist. frame leakage coef.	= 0.093 in^2/ft^2	-from ASHRAE Table F 23.3
Imp. window leakage coef.	= 0.026 in^2/ft^2	-from ASHRAE Table F 23.3
Imprv. frame leakage coef.	= 0.019 in^2/ft^2	-from ASHRAE Table F 23.3
# of doors	= 3 doors	-from bldg plans / survey notes
Door area	= 52 ft^2	-from bldg plans / survey notes
Exist. door leakage coef.	= 0.157 in^2/ft^2	-from ASHRAE Table F 23.3
Exist. frame leakage coef.	= 0.072 in^2/ft^2	-from ASHRAE Table F 23.3
Imprv. door leakage coef.	= 0.114 in^2/ft^2	-from ASHRAE Table F 23.3
Imprv. frame leakage coef.	= 0.0143 in^2/ft^2	-from ASHRAE Table F 23.3
Total door/win perimeter	= 440 ft	-from bldg plans / survey notes
Gas savings factor	= 0.025 MBtu/cfm	-from Bldg 100 simulation
Electric savings factor	= 5.8 kWh/cfm	-from Bldg 100 simulation
Demand savings factor	= 0.0 kW/cfm	-from Bldg 100 simulation
Gas Cost	= $4.67/MBtu	-from utility rate analysis
Electric Cost	= $0.0255/kWh	-from utility rate analysis
Demand Cost	= $8.85/kW	-from utility rate analysis

Existing Effective Leakage Area:

$(.052 + .093\ in^2/ft^2)*(380\ ft^2) + (.157 + .072\ in^2/ft^2)*(52\ ft^2)$
$= 66.9\ in^2$

Existing Window / Door Infiltration:

$66.9*(0.016*(17) + .0039*(12.65^2))\wedge 1/2 = 63$ cfm

Improved Effective Leakage Area:

$(.026 + .019\ in^2/ft^2)*(380\ ft^2) + (.114 + .0143\ in^2/ft^2)*(52\ ft^2)$
$= 23.7\ in^2$

Improved Window / Door Infiltration:

$23.7*(0.016*(17) + .0039*(12.65^2))\wedge 1/2 = 22$ cfm

Delta infiltration:

63 - 22 = 41 cfm

Peak Demand Savings:

(41 cfm)*(0.0 kW / cfm) = 0.0 kW

Annual Energy Savings:

- Gas:	(41 cfm)*(0.025 MBtu / cfm)	= 1.02 MBtu
- Electric:	(41 cfm)*(5.8 kWh / cfm)	= 187 kWh

Annual Cost Savings:

(1.02 MBtu)*($4.67 / MBtu) + (187 kWh)*($0.0255 / kWh) + (0.0 kW)*($8.85 / kW)*(4 + 0.95 * 8) = $10 / yr

Estimated Construction Cost:

$53.00 / window	-from engineer's cost estimate
$114.17 / door	-from engineer's cost estimate
$1.18 / ft of perimeter	-from engineer's cost estimate

($53.00 / ea)*(24 win) + ($114.17 / ea)*(3 doors) + ($1.18/ ft)*(440 ft)
= $2,133

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 3 – Weatherstripping & Caulking

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 17-Jul-92
FILE: ECO-3.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	23.77 UPWG
Electric Savings	$0.0255 / kWh	15.61 UPWE
Demand Savings	$8.85 / kW	14.53 UPW

Economic Life: 25 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON-ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
155	2	22	1	1	$5	$234	$0	$240	$1,485	2.4	6.2
TOTAL	2	22	1	1	$5	$234	$0	$240	$1,485	2.4	6.2

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 3 – Weatherstripping & Caulking

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-APR-92
FILE: ECO-3.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG #	TOTAL PERIM (ft)	# WIN	# DOORS	DELTA INFIL (cfm)	DEMAND SAVINGS (kW/cfm)	ELECTRIC SAVINGS (kWh/cfm)	GAS SAVINGS (MBtu/cfm)	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	UNIT CONST COST ($/ft)	UNIT CONST COST ($/win)	UNIT CONST COST ($/door)	CONST COST ($)
022	957	64	4	6	0	0.0037	0.052	0	0	0.33	$1.18	$53.00	$114.17	$4,978
027	1059	58	8	11	0	0.0037	0.052	0	0	0.57	$1.18	$53.00	$114.17	$5,237
028	1059	58	8	11	0	0.0037	0.052	0	0	0.57	$1.18	$53.00	$114.17	$5,237
040	1481	66	7	16	0.003	1.4	0.053	0.05	22	0.84	$1.18	$53.00	$114.17	$6,045
041	906	43	5	30	0	4.6	0.025	0	139	0.75	$1.18	$53.00	$114.17	$3,919
056	2416	120	4	295	0.003	1.4	0.053	0.89	413	15.64	$1.18	$53.00	$114.17	$9,668
058	2416	120	4	295	0.003	1.4	0.053	0.89	413	15.64	$1.18	$53.00	$114.17	$9,668
060	2983	152	9	336	0.003	1.4	0.053	1.01	470	17.81	$1.18	$53.00	$114.17	$12,603
061	733	31	9	71	0	4.6	0.025	0	326	1.77	$1.18	$53.00	$114.17	$3,535
100	422	23	4	5	0	4.6	0.025	0	23	0.13	$1.18	$53.00	$114.17	$2,174
101	1064	53	3	123	0	4.6	0.025	0	565	3.07	$1.18	$53.00	$114.17	$4,407
105	102	12	3	24	0	4.6	0.025	0	112	0.61	$1.18	$53.00	$114.17	$1,099
109	519	29	3	43	0	4.6	0.025	0	199	1.08	$1.18	$53.00	$114.17	$2,492
111	440	24	3	41	0	4.6	0.025	0	187	1.02	$1.18	$53.00	$114.17	$2,133
112	357	20	2	33	0	4.6	0.025	0	153	0.83	$1.18	$53.00	$114.17	$1,710
114	421	24	2	39	0	4.6	0.025	0	180	0.98	$1.18	$53.00	$114.17	$1,997
116	312	16	3	29	0	4.6	0.025	0	132	0.72	$1.18	$53.00	$114.17	$1,558
117	440	24	3	41	0	4.6	0.025	0	187	1.02	$1.18	$53.00	$114.17	$2,133
118	440	24	3	41	0	4.6	0.025	0	187	1.02	$1.18	$53.00	$114.17	$2,133
120	440	24	3	41	0	4.6	0.025	0	187	1.02	$1.18	$53.00	$114.17	$2,133
121	248	12	3	23	0	4.6	0.025	0	105	0.57	$1.18	$53.00	$114.17	$1,271
122	440	24	3	41	0	4.6	0.025	0	187	1.02	$1.18	$53.00	$114.17	$2,133
124	406	24	3	36	0	4.6	0.025	0	165	0.90	$1.18	$53.00	$114.17	$2,094
126	406	24	3	36	0	4.6	0.025	0	165	0.90	$1.18	$53.00	$114.17	$2,094
155	262	15	2	23	0.1	0.95	0.044	2.3	22	1.00	$1.18	$53.00	$114.17	$1,332
358	2286	145	15	13	0	−0.31	−0.00015	0	−4	−0.00	$1.18	$53.00	$114.17	$12,095
522	646	41	3	7	0	0.5	0.035	0	4	0.25	$1.18	$53.00	$114.17	$3,278

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 3 – Weatherstripping & Caulking

CLIENT CONTRACT NO: DACA21–91–C–0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15–APR–92
FILE: ECO–3.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG #	# STORIES	A	B	WALL CONST.	# WIN.	GLASS TYPE	WIN TYPE	INFIL DESCRIP	WIN (in²/ft²)	FRAME (in²/ft²)	L (in)	W (in)	WIN PERIM (ft)	WIN AREA (ft²)	L eff (in²)	# DOORS	INFIL DESCRIP	DOOR (in²/ft²)	FRAME (in²/ft²)	L (in)	W (in)
022	1	0.016	0.004	Mason	64	Db	Cas	Low	0.011	0.019	34	47	864	710	21	2	Low	0.114	0.0143	80	60
																2	High	0.157	0.072	80	60
027																					
028																					
040	2	0.031	0.005	Mason	48	Si	SI	Low	0.026	0.019	73	40	904	973	44	2	Med to High	0.157	0.072	72	30
					18			Low	0.026	0.019	80	64	432	640	29	3	High	0.157	0.072	84	60
																2	Low	0.114	0.0143	84	34
041	2	0.031	0.005	Mason	43	Db	SI	Low	0.037	0.019	32	81	810	774	43	2	Low	0.114	0.0143	80	35
																3	Med to High	0.157	0.072	80	35
056	2	0.031	0.005	Mason	120	Si	SI	High	0.052	0.093	80	36	2320	2400	348	4	High	0.157	0.072	84	60
058	2	0.031	0.005	Mason	120	Si	SI	High	0.052	0.093	80	36	2320	2400	348	4	High	0.157	0.072	84	60
060																					
061	1	0.016	0.004	Mason	10	Si	SI	Med to High	0.052	0.093	85	40	208	236	34	2	Fair	0.157	0.072	84	30
					5	Si	SI	Med to High	0.052	0.093	85	40	104	118	17	2		0.157	0.072	80	36
					3	Si	SI	Med to High	0.052	0.093	63	39	51	51	7	4	High	0.157	0.072	80	30
					2	Si	SI	Med to High	0.052	0.093	53	44	32	32	5	1	Fair to High	0.157	0.072	84	30
					2	Si	SI	Med to High	0.052	0.093	63	39	34	34	5		High	0.157	0.072		
					3	Si	SI	Med to High	0.052	0.093	63	39	51	51	7						
					3	Si	SI	Med to High	0.052	0.093	63	31	47	41	6						
					3	Si	SI	Med to High	0.052	0.093	36	36	36	27	4						
100																					
101	2	0.031	0.005	Mason	53	Si	SI	Med	0.052	0.093	80	34	1007	1001	145	3	Med to High	0.157	0.072	80	34
105	1	0.016	0.004	Mason	4	Db	SI	Fair	0.074	0.093	40	28	45	31	5	3	Fair	0.157	0.072	80	34
					8	Db	SI	Fair	0.074	0.093	48	56	139	149	25						
109	1	0.016	0.004	Mason	29	Si	SI	Fair	0.052	0.093	53	43	464	459	67	3	Low	0.114	0.0143	79	31
111	1	0.016	0.004	Mason	24	Si	SI	High	0.052	0.093	53	43	384	380	55	3	Fair	0.157	0.072	80	31
112	1	0.016	0.004	Mason	20	Si	SI	Fair	0.052	0.093	53	43	320	317	46	2	High	0.157	0.072	80	32
114	1	0.016	0.004	Mason	24	Si	SI	High	0.052	0.093	53	43	384	380	55	2	Fair	0.157	0.072	80	31
116	1	0.016	0.004	Mason	16	Si	SI	High	0.052	0.093	53	43	256	253	37	3	Fair	0.157	0.072	80	31
117	1	0.016	0.004	Mason	24	Si	SI	High	0.052	0.093	53	43	384	380	55	3	Fair	0.157	0.072	80	31
118	1	0.016	0.004	Mason	24	Si	SI	High	0.052	0.093	53	43	384	380	55	3	Fair	0.157	0.072	80	31
120	1	0.016	0.004	Mason	24	Si	SI	High	0.052	0.093	53	43	384	380	55	3	Fair	0.157	0.072	80	31
121	1	0.016	0.004	Mason	12	Si	SI	High	0.052	0.093	53	43	192	190	28	3	Fair	0.157	0.072	80	31
122	1	0.016	0.004	Mason	24	Si	SI	High	0.052	0.093	53	43	384	380	55	3	Fair	0.157	0.072	80	31
124	1	0.016	0.004	Mason	24	Si	SI	Fair	0.052	0.093	51	33	336	281	41	3	Fair	0.157	0.072	80	60
126	1	0.016	0.004	Mason	24	Si	SI	Fair	0.052	0.093	51	33	336	281	41	3	Fair	0.157	0.072	80	60
155	1	0.016	0.004	Mason	3	Si	SI	Med to High	0.052	0.093	40	30	35	25	4	2	Med to High	0.157	0.072	80	60
					12	Si	SI	Med to High	0.052	0.093	60	30	180	150	22						
358																					
522	2	0.031	0.005	Mason	32	Db	SI	Low	0.037	0.019	60	30	480	400	22	3	Fair	0.157	0.072	80	36
					9	Db	SI	Low	0.037	0.01[illegible]	48	24	108	72	4						

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 3 – Weatherstripping & Caulking

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-APR-92
FILE: ECO-3.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG #	DOOR PERIM (FT)	DOOR AREA (ft²)	L eff (in²)	TOTAL L eff (in²)	IMPRV WIN (in²/ft²)	IMPRV FRAME (in²/ft²)	IMPRV DOOR (in²/ft²)	IMPRV FRAME (in²/ft²)	IMPRV L eff (in²)	EXIST INFIL (cfm)	IMPRV INFIL (cfm)	DELTA INFIL (cfm)	TOTAL PERIM (ft)	# WIN	# DOORS	OH DOORS PERIM (ft)
022	47	67	9	45.1	0.011	0.019	0.114	0.0143	38.4	43	36	6	957	64	4	
	47	67	15													
027										552	541	11	1059	58	8	
028										552	541	11	1059	58	8	
040	34	30	7	108.6	0.026	0.019	0.114	0.0143	95.0	126	110	16	1481	66	7	
	72	105	24													
	39	40	5													
041	38	39	5	61.7	0.011	0.019	0.114	0.0143	35.7	72	41	30	906	43	5	
	58	58	13													
056	96	140	32	380.1	0.026	0.019	0.114	0.0143	126.0	441	146	295	2416	120	4	
058	96	140	32	380.1	0.026	0.019	0.114	0.0143	126.0	441	146	295	2416	120	4	
060										4171	3835	336	2983	152	9	
061	38	35	8	122.1	0.026	0.019	0.114	0.0143	47.0	115	44	71	733	31	9	
	39	40	9													
	73	67	15													
	19	18	4													
	0	0														
100										424	419	5	422	23	4	
101	57	57	13	158.1	0.026	0.019	0.114	0.0143	52.3	184	61	123	1064	53	3	
105	57	57	13	43.1	0.037	0.019	0.114	0.0143	17.4	41	16	24	102	12	3	
109	55	51	7	73.1	0.026	0.019	0.114	0.0143	27.2	69	26	43	519	29	3	
111	56	52	12	66.9	0.026	0.019	0.114	0.0143	23.7	63	22	41	440	24	3	
112	37	36	8	54.0	0.026	0.019	0.114	0.0143	18.8	51	18	33	357	20	2	
114	37	34	8	63.0	0.026	0.019	0.114	0.0143	21.5	59	20	39	421	24	2	
116	56	52	12	48.5	0.026	0.019	0.114	0.0143	18.0	46	17	29	312	16	3	
117	56	52	12	66.9	0.026	0.019	0.114	0.0143	23.7	63	22	41	440	24	3	
118	56	52	12	66.9	0.026	0.019	0.114	0.0143	23.7	63	22	41	440	24	3	
120	56	52	12	66.9	0.026	0.019	0.114	0.0143	23.7	63	22	41	440	24	3	
121	56	52	12	39.4	0.026	0.019	0.114	0.0143	15.2	37	14	23	248	12	3	
122	56	52	12	66.9	0.026	0.019	0.114	0.0143	23.7	63	22	41	440	24	3	
124	70	100	23	63.6	0.026	0.019	0.114	0.0143	25.5	60	24	36	406	24	3	
126	70	100	23	63.6	0.026	0.019	0.114	0.0143	25.5	60	24	36	406	24	3	
155	47	67	15	40.6	0.026	0.019	0.114	0.0143	16.4	38	15	23	262	15	2	
358												13	2286	145	15	
522	58	60	14	40.2	0.037	0.019	0.114	0.0143	34.1	47	40	7	646	41	3	

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO.	DACA 21-91-C-0097
X CODE A / CODE B / CODE C / OTHER	
EFFECTIVE PRICING DATE	APR 92
DATE PREPARED	15-Apr-92
PROJECT	Ft. McPherson & Ft. Gillem ESOS Study
LOCATION	Ft. McPherson & Ft Gillem
DRAWING NO.	
SHT OF	
ESTIMATOR	RMG
CHECKED BY	

ECO 3 – Weatherstripping & Caulking	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
ASTRAGAL, OVERHEAD DOOR	1	LF	0.178	0.178	$18.53	$3.30			$2.50	$2.50	$5.80		
SUBTOTAL						$3.30					$5.80		
OVERHEAD, BOND	15%					$0.49					$0.87		
PROFIT	10%					$0.33					$0.58		
COST SUB-TOTAL						$4.12					$7.25		
CONTINGENCY	15%					$0.62					$1.09		
TOTAL						$4.74					$8.34		
WEATHERSTRIPPING, WINDOW	1	EA	1.110	1.110	$18.53	$20.57			$16.30	$16.30	$36.87		
SUBTOTAL						$20.57					$36.87		
OVERHEAD, BOND	15%					$3.09					$5.53		
PROFIT	10%					$2.06					$3.69		
COST SUB-TOTAL						$25.71					$46.09		
CONTINGENCY	15%					$3.86					$6.91		
TOTAL						$29.57					$53.00		
WEATHERSTRIPPING, DOOR	1	EA	2.7	2.667	$18.53	$49.42			$30.00	$30.00	$79.42		
SUBTOTAL						$49.42					$79.42		
OVERHEAD, BOND	15%					$7.41					$11.91		
PROFIT	10%					$4.94					$7.94		
COST SUB-TOTAL						$61.77					$99.27		
CONTINGENCY	15%					$9.27					$14.89		
TOTAL						$71.04					$114.17		
CAULKING, SILICONE	1	LF	0.031	0.031	$19	$0.57			$0.25	$0.25	$0.82		
SUBTOTAL						$0.57					$0.82		
OVERHEAD, BOND	15%					$0.09					$0.12		
PROFIT	10%					$0.06					$0.08		
COST SUB-TOTAL						$0.72					$1.02		
CONTINGENCY	15%					$0.11					$0.15		
TOTAL						$0.83					$1.18		

DA FORM 5416-R, APR 85

ECO-5, INSTALL HIGH EFFICIENCY ELECTRIC MOTORS

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: MECO25
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-5 HIGH EFFICIENCY MOTOR
ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	146176.
B. SIOH	$	8040.
C. DESIGN COST	$	8771.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	162987.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	902.	$ 6739.	15.61	105199.
B. DIST	$ .00	0.	$ 0.	21.66	0.
C. RESID	$ .00	0.	$ 0.	26.51	0.
D. NAT G	$ 4.67	0.	$ 0.	23.77	0.
E. COAL	$ .00	0.	$ 0.	16.06	0.
F. TOTAL		902.	$ 6739.		$ 105199.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) — $ 5594.
(1) DISCOUNT FACTOR (TABLE A) — 14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) — $ 81281.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 81281.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 34716.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) .86
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 12333.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 186480.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.14
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 13.22

HIGH-EFFICIENCY MOTOR REPLACEMENT SAMPLE CALCULATION, ECO #5
BUILDING 40

Given:

Motor Horsepower	= 3 hp	-from field survey
Operation Hours	= 8,760 hrs / yr	-from field survey
Standard Motor Efficiency	= 84%	-from standard motor info
High Eff Motor Efficiency	= 88.5%	-from high efficiency motor info
Motor Load Factor	= 85%	-assumed
Gas Cost	= $4.67 / MBtu	-from utility rate analysis
Electric Cost	= $0.0255 / kWh	-from utility rate analysis
Demand Cost	= $8.85 / kW	-from utility rate analysis

Existing Demand:

$$\frac{(3\ \text{hp}) * (0.746\ \text{kw/ hp}) * (85\%)}{(84\%)} = 2.26\ \text{kw}$$

Improved Demand:

$$\frac{(3\ \text{hp}) * (0.746\ \text{kw / hp}) * (85\%)}{(88.5\%)} = 2.15\ \text{kw}$$

Peak Demand Savings:

2.26 kW - 2.15 kW = 0.11 kW

Annual Electric Savings:

(0.11 kW)*(8,760 hrs / yr) = 964 kWh / yr

Annual Cost Savings:

(0.0 MBtu)*($4.67 / MBtu) + (964 kWh)*($0.0255 / kWh) + (0.11 kW)*($8.85 / kW)*(4 + 0.95 * 8) = $36 / yr

Estimated Construction Cost:

$624 / 3 hp motor -from engineer's cost estimate

INSTALL HIGH EFFICIENCY MOTORS
ECO #5, Ft. McPherson

Variable Speed Drive Load Factor

Percentage breakdown of Cooling Airflow
- from Computer Simulation

Load %	Hours %	Power Input Ratio Fm. T.2 p.2
70	56	0.43
80	13	0.62
90	7	0.85
100	24	1.16

$$\text{Load Factor} = \frac{(56)(0.43) + (13)(0.62) + (7)(0.85) + (24)(1.16)}{100}$$

Load Factor = **66%**

Profit Improvement With Variable Frequency Drives

SCOTT A. MOSES*
WAYNE C. TURNER, *Ph.D., P.E., CEM*
JORGE B. WONG
MARK R. DUFFER
Oklahoma State University
Stillwater, OK

Table 1. Values for Calculating Annual Savings

Load Ratio 1	Power Input Ratio (Old) 2	Power Input Ratio (VFD) 3	Duty Cycle Fraction 4	KWh Saved 5	Dollar Savings 6
0.20	__.__	0.09	0.00	____	____
0.30	__.__	0.11	0.05	____	____
0.40	__.__	0.14	0.16	____	____
0.50	__.__	0.20	0.23	____	____
0.60	__.__	0.29	0.23	____	____
0.70	__.__	0.43	0.20	____	____
0.80	__.__	0.62	0.09	____	____
0.90	__.__	0.85	0.03	____	____
1.00	__.__	1.16	0.01	____	____

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 16-Jul-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	$4.67 / MBtu	23.77 UPWG
Electric Savings	$0.0255 / kWh	15.61 UPWE
Demand Savings	$8.85 / kW	14.53 UPW

Economic Life: 25 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS ($/yr)	ANNUAL DEMAND SAVINGS ($/yr)	ANNUAL NON-ENERGY SAVINGS ($/yr)	TOTAL ANNUAL SAVINGS ($/yr)	CONST COST ($)	SIR	SIMPLE PAYBACK (yrs)
514	0	3,004	0	10	$77	$35	$0	$112	$782	2.2	7.0
206	1	8,329	0	28	$212	$98	$0	$310	$2,207	2.1	7.1
360	0	3,294	0	11	$84	$39	$0	$123	$1,103	1.7	9.0
200	37	167,856	0	572	$4,280	$3,839	$0	$8,119	$107,960	1.1	13.3
056	1	8,276	0	28	$211	$97	$0	$308	$4,126	1.1	13.4
058	1	8,276	0	28	$211	$97	$0	$308	$4,126	1.1	13.4
060	1	8,276	0	28	$211	$97	$0	$308	$4,126	1.1	13.4
062	1	8,276	0	28	$211	$97	$0	$308	$4,126	1.1	13.4
246	1	4,700	0	16	$120	$64	$0	$183	$2,544	1.1	13.9
363	7	23,735	0	81	$605	$763	$0	$1,368	$18,911	1.1	13.8
· 181	1	7,786	0	27	$199	$122	$0	$320	$4,478	1.1	14.0
400	0	2,377	0	8	$61	$28	$0	$88	$1,269	1.1	14.3
168	0	1,452	0	5	$37	$17	$0	$54	$782	1.1	14.5
401	0	1,452	0	5	$37	$17	$0	$54	$782	1.1	14.5
131	0	726	0	2	$19	$34	$0	$53	$782	1.0	14.9
170	1	4,785	0	16	$122	$112	$0	$234	$3,524	1.0	15.0
101	0	1,919	0	7	$49	$39	$0	$88	$1,359	1.0	15.5
TOTAL	54	264,518	0	902	$6,745	$5,594	$0	$12,339	$182,986	1.1	13.2

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE:
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	NOTE	OVER / UNDER SIZED	NAMEPLATE HP	NAMEPLATE FLA	NAMEPLATE VOLTS	NAMEPLATE EFF	MEASURED AMPS	MEASURED PF	MEASURED VOLTS	LOAD FACTOR (%)	EXIST EFF	IMPRVD EFF	DEMAND SAVINGS (kW)	HRS/ YEAR	ELECTRIC SAVINGS (kWh/yr)
022	CWP			2.0	5.7	208	0.79				85%	79.0%	86.5%	0.14	4380	610
	TOTAL			2.0										0.1		610
040	DTW PUMP			3.0	9.2	230					85%	84.0%	88.5%	0.12	8760	1,009
	TOTAL			3.0										0.1		1,009
041	AHU 2			1.0	3.5	200					85%	77.0%	86.5%	0.09	8760	792
	AHU 3			1.0	3.5	200					85%	77.0%	86.5%	0.09	8760	792
	TOTAL			2.0										0.2		1,585
042	AHU 1			3.0	8.3	230					85%	84.0%	88.5%	0.12	8760	1,009
	HWP			1.5	5.3	208	0.78				85%	78.0%	86.5%	0.12	4380	525
	TOTAL			4.5										0.2		1,534
056,058	DTWP 1			5.0	5.4	230					85%	85.5%	89.5%	0.17	8760	1,452
060,062	DTWP 2			10.0	29	208					85%	87.5%	91.7%	0.33	8760	2,908
	DTWP 3			10.0	29	230					85%	87.5%	91.7%	0.33	8760	2,908
	DTWP 4			3.0	9	230					85%	84.0%	88.5%	0.12	8760	1,009
	TOTAL			28.0										0.9		8,276
061	HWP 1			2.0	6.8	200					85%	80.0%	86.5%	0.12	4380	522
	HWP 2			3.0	9.2	200					85%	84.0%	88.5%	0.12	4380	504
	TOTAL			5.0										0.2		1,026
100	AHU 1			2.0	7.1	200					85%	80.0%	86.5%	0.12	8760	1,044
	TOTAL			2.0										0.1		1,044
101	DTW			5.0	14.8	208					85%	85.5%	89.5%	0.17	8760	1,452
	SUMP PUMP			1.0	12.4	1115	0.67				85%	67.0%	86.5%	0.21	2190	467
	TOTAL			6.0										0.4		1,919
131	HWP 1			5.0	13.8	208	0.855				85%	85.5%	89.5%	0.17	4380	726
	HWP 2	Off		5.0	13.8	208	0.855				85%	85.5%	89.5%	0.17		
	TOTAL			10.0										0.3		726
155	AHU 1			1.0	3.8	200					85%	77.0%	86.5%	0.09	4380	396
	AHU 2			2.0	6.8	208	0.785				85%	78.5%	86.5%	0.15	4380	654
	TOTAL			3.0										0.2		1,051
168	DTWP			5.0	16	200					85%	85.5%	89.5%	0.17	8760	1,452
	TOTAL			5.0										0.2		1,452
170	CHWP			15	42	208	0.885				85%	88.5%	92.4%	0.45	4380	1,987
	HW PUMP			15	38	230	0.87	38	0.83	208	85%	87.0%	92.4%	0.64	4380	2,799
	TOTAL			30.0										1.1		4,785

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE:
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	NOTE	OVER / UNDER SIZED	NAMEPLATE HP	NAMEPLATE FLA	NAMEPLATE VOLTS	NAMEPLATE EFF	MEASURED AMPS	MEASURED PF	MEASURED VOLTS	LOAD FACTOR (%)	EXIST EFF	IMPRVD EFF	DEMAND SAVINGS (kW)	HRS/ YEAR	ELECTRIC SAVINGS (kWh/yr)
171	AHU 1	Off		5.0	16.2	200					85%	85.5%	89.5%	0.17	0	
	AHU 2	Off		5.0	16	200					85%	85.5%	89.5%	0.17	0	
	AHU 3			5.0	16	200					85%	85.5%	89.5%	0.17	4380	726
	HW PUMP			15.0	4.7	200					85%	88.5%	92.4%	0.45	4380	1,987
	CWP			10	31.2	200					85%	87.5%	91.7%	0.33	4380	1,454
	TOTAL			40.0										1.3		4,167
181	AHU 1		OVER	10.0	27.0	230	0.86	21.0	0.79	204	85%	86.0%	91.7%	0.46	8760	4,015
	AHU 2			1.5	5.9	200					85%	77.0%	86.5%	0.14	8760	1,188
	CWP 1			5	13.2	230					85%	85.5%	89.5%	0.17	4380	726
	CWP 2			7.5	18.8	230					85%	86.5%	91.7%	0.31	4380	1,366
	HWP			1.5	1.2	208	0.785				85%	78.5%	86.5%	0.11	4380	491
	TOTAL			25.5										1.2		7,786
184	AHU 1			1.0	4.2	200					85%	77.0%	86.5%	0.09	8760	792
	AHU 2			1.0	3.6	208					85%	77.0%	86.5%	0.09	8760	792
	AHU 3			2	6.2	208	0.815				85%	81.5%	86.5%	0.09	8760	788
	AHU 4			2	6.6	200					85%	80.0%	86.5%	0.12	8760	1,044
	AHU 5			2	6.8	208					85%	80.0%	86.5%	0.12	8760	1,044
	AHU 6			1.5	5.5	200	0.785				85%	78.5%	86.5%	0.11	8760	982
	AHU 7			1.5	5.5	200	0.785				85%	78.5%	86.5%	0.11	8760	982
	AHU 8			1.5	5.5	200	0.785				85%	78.5%	86.5%	0.11	8760	982
	AHU 9			1.5	5.5	200	0.785				85%	78.5%	86.5%	0.11	8760	982
	AHU 10			1.5	5.5	200	0.785				85%	78.5%	86.5%	0.11	8760	982
	DTP			5	15.8	200					85%	85.5%	89.5%	0.17	8760	1,452
	TOTAL			20.5										1.2		10,820

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 01-Sep-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	NOTE	OVER / UNDER SIZED	NAMEPLATE HP	NAMEPLATE FLA	NAMEPLATE VOLTS	NAMEPLATE EFF	MEASURED AMPS	MEASURED PF	MEASURED VOLTS	LOAD FACTOR (%)	EXIST EFF	IMPRVD EFF	DEMAND SAVINGS (kW)	HRS/ YEAR	ELECTRIC SAVINGS (kWh/yr)
200	AHU 1, SUPPLY	VS		30.0	25	460		17.8	0.59	472	66%	90.2%	93.6%	0.59	5658	3,366
	AHU 1, RETURN	VS		10	–	460		7.4	0.5	469	66%	87.5%	91.7%	0.26	5658	1,458
	AHU 2, SUPPLY	VS		25	64	460	0.875	14.4	0.69	225	66%	87.5%	93.0%	0.83	5658	4,707
	AHU 2, RETURN	VS		10	12	460	0.855	14	0.83	470	66%	85.5%	91.7%	0.39	5658	2,203
	AHU 3, SUPPLY	VS		30	30	460		16	0.48	468	66%	90.2%	93.6%	0.59	5658	3,366
	AHU 3, RETURN	VS		15	15	460		8.8	0.52	468	66%	88.5%	92.4%	0.35	5658	1,993
	AHU 4, SUPPLY	VS		30	30	460		17	0.46	460	66%	90.2%	93.6%	0.59	5658	3,366
	AHU 4, RETURN	VS		10	10	460		12	0.57	468	66%	87.5%	91.7%	0.26	5658	1,458
	AHU 5, SUPPLY	VS		40	30	460		22.6	0.52	471	66%	91.0%	94.1%	0.71	5658	4,034
	AHU 5, RETURN	VS		15	15	460		10	0.5	466	66%	88.5%	92.4%	0.35	5658	1,993
	AHU 6, SUPPLY	VS		40	40	460		19.8	0.99	469	66%	91.0%	94.1%	0.71	5658	4,034
	AHU 6, RETURN	VS		15	230	460		11.5	0.64	468	66%	88.5%	92.4%	0.35	5658	1,993
	AHU 7, SUPPLY	VS		30	30	460		18.4	0.51	473	66%	90.2%	93.6%	0.59	8760	5,211
	AHU 7, RETURN	VS		10	–	460		7.5	0.48	473	66%	87.5%	91.7%	0.26	8760	2,258
	AHU 8, SUPPLY	VS		40	40	460		11	0.97	472	66%	91.0%	94.1%	0.71	5658	4,034
	AHU 8, RETURN	VS		10	10	460		10.7	0.52	472	66%	87.5%	91.7%	0.26	5658	1,458
	AHU 9, SUPPLY	VS		30	25	460		21	0.6	473	66%	90.2%	93.6%	0.59	5658	3,366
	AHU 9, RETURN	VS		10	10	460		9.5	0.57	472	66%	87.5%	91.7%	0.26	5658	1,458
	AHU 10, SUPPLY	VS		40	30	460		26	0.97	473	66%	91.0%	94.1%	0.71	5658	4,034
	AHU 10, RETURN	VS		15	15	460		9.2	0.46	474	66%	88.5%	92.4%	0.35	5658	1,993
	AHU 11, SUPPLY	VS		30	30	460		22.2	0.61	473	66%	90.2%	93.6%	0.59	5658	3,366
	AHU 11, RETURN	VS		15	15	460		8	0.5	473	66%	88.5%	92.4%	0.35	5658	1,993
	AHU 12, SUPPLY	VS		40	40	460		25.8	0.99	472	66%	91.0%	94.1%	0.71	5658	4,034
	AHU 12, RETURN	VS		15	15	460		12.6	0.65	472	66%	88.5%	92.4%	0.35	5658	1,993
	AHU 13, SUPPLY			5	7.6	460					85%	85.5%	89.5%	0.17	8760	1,452
	AHU 13, RETURN			1	1.8	460					85%	77.0%	86.5%	0.09	8760	792
	AHU 14, SUPPLY	VS		60	50	460		12.6	0.98	467	66%	93.0%	94.5%	0.50	8760	4,417
	AHU 14, RETURN	VS		25	25	460		30.3	0.67	467	66%	90.2%	93.0%	0.41	8760	3,599
	AHU 16, SUPPLY			5	7.6	460					85%	85.5%	89.5%	0.17	8760	1,452
	AHU 16, RETURN			1	1.8	460					85%	77.0%	86.5%	0.09	8760	792
	AHU 17, SUPPLY			3	4.8	460		2.6	0.41	470	85%	84.0%	88.5%	0.12	8760	1,009
	COND PUMP#1	Off		75	87	460	0.887				85%	88.7%	94.5%	3.29		
	COND PUMP#2	Off		75	87	460	0.887				85%	88.7%	94.5%	3.29		
	COND PUMP#3			75	87	460	0.887	77.3	0.85	472	85%	88.7%	94.5%	3.29	8760	28,827
	CONST PRESS			25	34	460					85%	90.2%	93.0%	0.53	8760	4,635

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 01-Sep-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	NOTE	OVER / UNDER SIZED	NAMEPLATE HP	NAMEPLATE FLA	NAMEPLATE VOLTS	NAMEPLATE EFF	MEASURED AMPS	MEASURED PF	MEASURED VOLTS	LOAD FACTOR (%)	EXIST EFF	IMPRVD EFF	DEMAND SAVINGS (kW)	HRS/ YEAR	ELECTRIC SAVINGS (kWh/yr)
200	CHWP#1	Off		30	37	460	0.883				85%	88.3%	93.6%	1.22		
CONT.	CHWP#2	Off		30	37	460	0.883				85%	88.3%	93.6%	1.22		
	CHWP#3			30	37	460	0.883	27.3	0.83	472	85%	88.3%	93.6%	1.22	8760	10,686
	CHWP#4	Off, VS		60	70	460					66%	93.0%	94.5%	0.50		
	CHWP#4A	VS		60	70	460		25.5	0.64	32	66%	93.0%	94.5%	0.50	8760	4,417
	CHWP#5	Off, VS		50	60	460					66%	91.7%	94.1%	0.68		
	CHWP#6	VS		50	60	460	0.903	46	0.64	456	66%	90.3%	94.1%	1.10	8760	9,644
	C TOWER#1			50	65	460		36	0.82	472	85%	91.7%	94.1%	0.88	8760	7,725
	C TOWER#2			50	65	460					85%	91.7%	94.1%	0.88	4380	3,862
	C TOWER#3	Off		50	65	460					85%	91.7%	94.1%	0.88		
	AIR COMP#1			20	27	460	0.875	22	0.77	472	85%	87.5%	93.0%	0.86	4380	3,754
	AIR COMP#2			20	26.5	460	0.875				85%	87.5%	93.0%	0.86		
	HWP#1	Off		3	4.3	460					85%	84.0%	88.5%	0.12		
	HWP#2			3	4.3	460					85%	84.0%	88.5%	0.12	8760	1,009
	HWP#3	Off		1.5	2.6	460					85%	77.0%	86.5%	0.14		
	HWP#4			5	6.5	460					85%	85.5%	89.5%	0.17	8760	1,452
	HWP#5			5	6.5	460					85%	85.5%	89.5%	0.17	8760	1,452
	HWP#6	Off		3	4.5	460					85%	84.0%	88.5%	0.12		
	HWP#7			3	4.5	460					85%	84.0%	88.5%	0.12	8760	1,009
	HWP#8	Off		3	4.3	460					85%	84.0%	88.5%	0.12		
	HWP#9			7.5	9.3	460					85%	86.5%	91.7%	0.31	8760	2,731
	HWP#10	Off		5	6.5	460					85%	85.5%	89.5%	0.17		
	DCW PUMP#1			15	19	460					85%	88.5%	92.4%	0.45	8760	3,974
	DCW PUMP#2	Off		15	19	460					85%	88.5%	92.4%	0.45		
	DCW PUMP#3	Off		15	19	460					85%	88.5%	92.4%	0.45		
	TOTAL			1,489										37.4		167,856
206	DTWP#1			7.5	24	208	0.84				85%	84.0%	91.7%	0.48	8760	4,165
	DTWP#2			7.5	24	208	0.84				85%	84.0%	91.7%	0.48	8760	4,165
	TOTAL			15.0										1.0		8,329
246	CW PUMP			5	15.6	200					85%	85.5%	89.5%	0.17	4380	726
	AHU		OVER	15	43	208		31	0.66	206	85%	88.5%	92.4%	0.45	8760	3,974
	TOTAL			20.0										0.6		4,700

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE:
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	NOTE	OVER / UNDER SIZED	NAMEPLATE HP	NAMEPLATE FLA	NAMEPLATE VOLTS	NAMEPLATE EFF	MEASURED AMPS	MEASURED PF	MEASURED VOLTS	LOAD FACTOR (%)	EXIST EFF	IMPRVD EFF	DEMAND SAVINGS (kW)	HRS/ YEAR	ELECTRIC SAVINGS (kWh/yr)
358	AHU 1			5.0	16.6	200					85%	85.5%	89.5%	0.17	4380	726
	AHU 3			1	3.8	230					85%	77.0%	86.5%	0.09	4380	396
	AHU 4			2	6.5	208					85%	80.0%	86.5%	0.12	4380	522
	AHU 6			3	9.2	230					85%	84.0%	88.5%	0.12	4380	504
	HW PUMP			2	7.8	200					85%	80.0%	86.5%	0.12	4380	522
	CW PUMP			3	21	200	0.855				85%	85.5%	88.5%	0.08	4380	330
	TOTAL			16.0										0.7		3,000
360	AHU			7.5	23	208	0.855				85%	85.5%	91.7%	0.38	8760	3,294
	TOTAL			7.5										0.4		3,294
363	AHU 1			10.0	12.5	460	0.856	12.0	0.88	477	85%	85.6%	91.7%	0.49	4015	1,978
	AHU 2			7.5	10.8	460					85%	86.5%	91.7%	0.31	4015	1,252
	AHU 3			5			0.81				85%	81.0%	89.5%	0.37	4015	1,493
	AHU 4			5	6.6	460	0.855				85%	85.5%	89.5%	0.17	4015	665
	AHU 5			3	4.5	460	0.815				85%	81.5%	88.5%	0.18	4015	741
	AHU 5A			3	4.3	460	0.82				85%	82.0%	88.5%	0.17	4015	684
	AHU 6			5	6.6	460	0.855				85%	85.5%	89.5%	0.17	4015	665
	AHU 7			7.5	10.8	460	0.84				85%	84.0%	91.7%	0.48	4015	1,909
	AHU 8			7.5	10.8	460	0.84				85%	84.0%	91.7%	0.48	4015	1,909
	AHU 9		OVER	15	19.5	460	0.885	9.9	0.45	465	85%	88.5%	92.4%	0.45	4015	1,821
	AHU 10		OVER	20	59	200	0.875	30	0.52	200	85%	87.5%	93.0%	0.86	4015	3,441
	AHU 11	No Acce														
	AHU 12			3	10.4	200	0.815				85%	81.5%	88.5%	0.18	4015	741
	AHU 13	No Acce														
	CHWP#1		OVER	15	18.3	460	0.885	12.8	0.92	482	85%	88.5%	92.4%	0.45	4380	1,987
	CHWP#2	Off		10	14	460	0.85				85%	85.0%	91.7%	0.55		
	HWP#1		OVER	10	12.2	460	0.885	7.5	0.85	477	85%	88.5%	91.7%	0.25	4380	1,095
	COOLING TOWER			7.5	11	460					85%	86.5%	91.7%	0.31	4380	1,366
	COND PUMP#1		OVER	15	19.5	460	0.885	9.9	0.79	475	85%	88.5%	92.4%	0.45	4380	1,987
	COND PUMP#2	Off		20	25	460	0.86				85%	86.0%	93.0%	1.11		
	TOTAL			169.0										7.4		23,735
400	AHU 1			1.5	5.0	200					85%	77.0%	86.5%	0.14	8760	1,188
	AHU 2			1.5	5	200					85%	77.0%	86.5%	0.14	8760	1,188
	TOTAL			3.0										0.3		2,377
401	AHU			5.0	14.6	208					85%	85.5%	89.5%	0.17	8760	1,452
	TOTAL			5.0										0.2		1,452

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE:
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	NOTE	OVER / UNDER SIZED	NAMEPLATE HP	NAMEPLATE FLA	NAMEPLATE VOLTS	NAMEPLATE EFF	MEASURED AMPS	MEASURED PF	MEASURED VOLTS	LOAD FACTOR (%)	EXIST EFF	IMPRVD EFF	DEMAND SAVINGS (kW)	HRS/ YEAR	ELECTRIC SAVINGS (kWh/yr)
500	AHU 1			3	10.7	208	0.815				85%	81.5%	88.5%	0.18	8760	1,617
	AHU 2			5	15	200	0.865				85%	86.5%	89.5%	0.12	8760	1,076
	AHU 3			5	15	200	0.865				85%	86.5%	89.5%	0.12	8760	1,076
	AHU 4			2	6.8	208	0.785				85%	78.5%	86.5%	0.15	8760	1,309
	AHU 5			2	5.5	208					85%	80.0%	86.5%	0.12	8760	1,044
	AHU 6			1		208					85%	77.0%	86.5%	0.09	8760	792
	AHU 7			1.5	5.5	208					85%	77.0%	86.5%	0.14	8760	1,188
	AHU 8			2	6.7	200					85%	80.0%	86.5%	0.12	8760	1,044
	EF 5			3	7.8	208					85%	84.0%	88.5%	0.12	8760	1,009
	CHW PUMP			5		208					85%	85.5%	89.5%	0.17	4380	726
	HW PUMP			5	5.5	208					85%	85.5%	89.5%	0.17	4380	726
	TOTAL			34.5										1.5		11,607
514	AHU 3			5.0	16.0	208	0.816				85%	81.6%	89.5%	0.34	8760	3,004
	TOTAL			5.0										0.3		3,004
522	CHWP			2.0	8.1	200					85%	80.0%	86.5%	0.12	4380	522
	HWP			2	4.2	200					85%	80.0%	86.5%	0.12	4380	522
	TOTAL			4.0										0.2		1,044

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE:
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	COST MOTOR ($)	COST LABOR ($)	SUB TOTAL ($)	OH&B 15%	PROFIT 10%	SUB TOTAL ($)	CONT 15%	TOTAL ($)
022	CWP	$359	$68	$427	$64	$43	$534	$80	$614
	TOTAL								$614
040	DTW PUMP	$366	$68	$434	$65	$43	$542	$81	$624
	TOTAL								$624
041	AHU 2	$292	$68	$360	$54	$36	$450	$67	$517
	AHU 3	$292	$68	$360	$54	$36	$450	$67	$517
	TOTAL								$1,035
042	AHU 1	$366	$68	$434	$65	$43	$542	$81	$624
	HWP	$328	$68	$396	$59	$40	$495	$74	$569
	TOTAL								$1,193
056,058	DTWP 1	$420	$68	$488	$73	$49	$610	$91	$701
060,062	DTWP 2	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	DTWP 3	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	DTWP 4	$366	$68	$434	$65	$43	$542	$81	$624
	TOTAL								$3,700
061	HWP 1	$359	$68	$427	$64	$43	$534	$80	$614
	HWP 2	$366	$68	$434	$65	$43	$542	$81	$624
	TOTAL								$1,237
100	AHU 1	$359	$68	$427	$64	$43	$534	$80	$614
	TOTAL								$614
101	DTW	$420	$68	$488	$73	$49	$610	$91	$701
	SUMP PUMP	$292	$68	$360	$54	$36	$450	$67	$517
	TOTAL								$1,219
131	HWP 1	$420	$68	$488	$73	$49	$610	$91	$701
	HWP 2								
	TOTAL								$701
155	AHU 1	$292	$68	$360	$54	$36	$450	$67	$517
	AHU 2	$359	$68	$427	$64	$43	$534	$80	$614
	TOTAL								$1,131
168	DTWP	$420	$68	$488	$73	$49	$610	$91	$701
	TOTAL								$701
170	CHWP	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	HW PUMP	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	TOTAL								$3,161

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE:
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	COST		SUB TOTAL ($)	OH&B 15%	PROFIT 10%	SUB TOTAL ($)	CONT 15%	TOTAL ($)
		MOTOR ($)	LABOR ($)						
171	AHU 1								
	AHU 2								
	AHU 3	$420	$68	$488	$73	$49	$610	$91	$701
	HW PUMP	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	CWP	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	TOTAL								$3,469
181	AHU 1	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	AHU 2	$328	$68	$396	$59	$40	$495	$74	$569
	CWP 1	$420	$68	$488	$73	$49	$610	$91	$701
	CWP 2	$616	$72	$688	$103	$69	$861	$129	$990
	HWP	$328	$68	$396	$59	$40	$495	$74	$569
	TOTAL								$4,017
184	AHU 1	$292	$68	$360	$54	$36	$450	$67	$517
	AHU 2	$292	$68	$360	$54	$36	$450	$67	$517
	AHU 3	$359	$68	$427	$64	$43	$534	$80	$614
	AHU 4	$359	$68	$427	$64	$43	$534	$80	$614
	AHU 5	$359	$68	$427	$64	$43	$534	$80	$614
	AHU 6	$328	$68	$396	$59	$40	$495	$74	$569
	AHU 7	$328	$68	$396	$59	$40	$495	$74	$569
	AHU 8	$328	$68	$396	$59	$40	$495	$74	$569
	AHU 9	$328	$68	$396	$59	$40	$495	$74	$569
	AHU 10	$328	$68	$396	$59	$40	$495	$74	$569
	DTP	$420	$68	$488	$73	$49	$610	$91	$701
	TOTAL								$6,421

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 17-Jul-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	COST MOTOR ($)	COST LABOR ($)	SUB TOTAL ($)	OH&B 15%	PROFIT 10%	SUB TOTAL ($)	CONT 15%	TOTAL ($)
200	AHU 1, SUPPLY	$1,639	$152	$1,791	$269	$179	$2,239	$336	$2,575
	AHU 1, RETURN	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	AHU 2, SUPPLY	$1,396	$146	$1,542	$231	$154	$1,928	$289	$2,217
	AHU 2, RETURN	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	AHU 3, SUPPLY	$1,639	$152	$1,791	$269	$179	$2,239	$336	$2,575
	AHU 3, RETURN	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	AHU 4, SUPPLY	$1,639	$152	$1,791	$269	$179	$2,239	$336	$2,575
	AHU 4, RETURN	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	AHU 5, SUPPLY	$2,212	$183	$2,395	$359	$239	$2,994	$449	$3,443
	AHU 5, RETURN	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	AHU 6, SUPPLY	$2,212	$183	$2,395	$359	$239	$2,994	$449	$3,443
	AHU 6, RETURN	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	AHU 7, SUPPLY	$1,639	$152	$1,791	$269	$179	$2,239	$336	$2,575
	AHU 7, RETURN	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	AHU 8, SUPPLY	$2,212	$183	$2,395	$359	$239	$2,994	$449	$3,443
	AHU 8, RETURN	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	AHU 9, SUPPLY	$1,639	$152	$1,791	$269	$179	$2,239	$336	$2,575
	AHU 9, RETURN	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	AHU 10, SUPPLY	$2,212	$183	$2,395	$359	$239	$2,994	$449	$3,443
	AHU 10, RETURN	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	AHU 11, SUPPLY	$1,639	$152	$1,791	$269	$179	$2,239	$336	$2,575
	AHU 11, RETURN	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	AHU 12, SUPPLY	$2,212	$183	$2,395	$359	$239	$2,994	$449	$3,443
	AHU 12, RETURN	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	AHU 13, SUPPLY	$420	$68	$488	$73	$49	$610	$91	$701
	AHU 13, RETURN	$292	$68	$360	$54	$36	$450	$67	$517
	AHU 14, SUPPLY	$3,235	$261	$3,496	$524	$350	$4,370	$656	$5,026
	AHU 14, RETURN	$1,396	$146	$1,542	$231	$154	$1,928	$289	$2,217
	AHU 16, SUPPLY	$420	$68	$488	$73	$49	$610	$91	$701
	AHU 16, RETURN	$292	$68	$360	$54	$36	$450	$67	$517
	AHU 17, SUPPLY	$366	$68	$434	$65	$43	$542	$81	$624
	COND PUMP#1								
	COND PUMP#2								
	COND PUMP#3	$3,853	$305	$4,158	$624	$416	$5,198	$780	$5,977
	CONST PRESS	$1,396	$146	$1,542	$231	$154	$1,928	$289	$2,217

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 17-Jul-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	COST MOTOR ($)	COST LABOR ($)	SUB TOTAL ($)	OH&B 15%	PROFIT 10%	SUB TOTAL ($)	CONT 15%	TOTAL ($)
200	CHWP#1								
CONT.	CHWP#2								
	CHWP#3	$1,639	$152	$1,791	$269	$179	$2,239	$336	$2,575
	CHWP#4								
	CHWP#4A	$3,235	$261	$3,496	$524	$350	$4,370	$656	$5,026
	CHWP#5								
	CHWP#6	$2,579	$229	$2,808	$421	$281	$3,510	$526	$4,036
	C TOWER#1	$2,579	$229	$2,808	$421	$281	$3,510	$526	$4,036
	C TOWER#2	$2,579	$229	$2,808	$421	$281	$3,510	$526	$4,036
	C TOWER#3								
	AIR COMP#1	$1,189	$141	$1,330	$199	$133	$1,662	$249	$1,912
	AIR COMP#2								
	HWP#1								
	HWP#2	$366	$68	$434	$65	$43	$542	$81	$624
	HWP#3								
	HWP#4	$420	$68	$488	$73	$49	$610	$91	$701
	HWP#5	$420	$68	$488	$73	$49	$610	$91	$701
	HWP#6								
	HWP#7	$366	$68	$434	$65	$43	$542	$81	$624
	HWP#8								
	HWP#9	$616	$72	$688	$103	$69	$861	$129	$990
	HWP#10								
	DCW PUMP#1	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	DCW PUMP#2								
	DCW PUMP#3								
	TOTAL								$96,825
206	DTWP#1	$616	$72	$688	$103	$69	$861	$129	$990
	DTWP#2	$616	$72	$688	$103	$69	$861	$129	$990
	TOTAL								$1,979
246	CW PUMP	$420	$68	$488	$73	$49	$610	$91	$701
	AHU	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	TOTAL								$2,282

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE:
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	COST MOTOR ($)	COST LABOR ($)	SUB TOTAL ($)	OH&B 15%	PROFIT 10%	SUB TOTAL ($)	CONT 15%	TOTAL ($)
358	AHU 1	$420	$68	$488	$73	$49	$610	$91	$701
	AHU 3	$292	$68	$360	$54	$36	$450	$67	$517
	AHU 4	$359	$68	$427	$64	$43	$534	$80	$614
	AHU 6	$366	$68	$434	$65	$43	$542	$81	$624
	HW PUMP	$359	$68	$427	$64	$43	$534	$80	$614
	CW PUMP	$366	$68	$434	$65	$43	$542	$81	$624
	TOTAL								$3,693
360	AHU	$616	$72	$688	$103	$69	$861	$129	$990
	TOTAL								$990
363	AHU 1	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	AHU 2	$616	$72	$688	$103	$69	$861	$129	$990
	AHU 3	$420	$68	$488	$73	$49	$610	$91	$701
	AHU 4	$420	$68	$488	$73	$49	$610	$91	$701
	AHU 5	$366	$68	$434	$65	$43	$542	$81	$624
	AHU 5A	$366	$68	$434	$65	$43	$542	$81	$624
	AHU 6	$420	$68	$488	$73	$49	$610	$91	$701
	AHU 7	$616	$72	$688	$103	$69	$861	$129	$990
	AHU 8	$616	$72	$688	$103	$69	$861	$129	$990
	AHU 9	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	AHU 10	$1,189	$141	$1,330	$199	$133	$1,662	$249	$1,912
	AHU 11								
	AHU 12	$366	$68	$434	$65	$43	$542	$81	$624
	AHU 13								
	CHWP#1	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	CHWP#2								
	HWP#1	$750	$76	$826	$124	$83	$1,033	$155	$1,188
	COOLING TOWER	$616	$72	$688	$103	$69	$861	$129	$990
	COND PUMP#1	$985	$114	$1,099	$165	$110	$1,374	$206	$1,580
	COND PUMP#2								
	TOTAL								$16,961
400	AHU 1	$328	$68	$396	$59	$40	$495	$74	$569
	AHU 2	$328	$68	$396	$59	$40	$495	$74	$569
	TOTAL								$1,138
401	AHU	$420	$68	$488	$73	$49	$610	$91	$701
	TOTAL								$701

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE:
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	COST MOTOR ($)	COST LABOR ($)	SUB TOTAL ($)	OH&B 15%	PROFIT 10%	SUB TOTAL ($)	CONT 15%	TOTAL ($)
500	AHU 1	$366	$68	$434	$65	$43	$542	$81	$624
	AHU 2	$420	$68	$488	$73	$49	$610	$91	$701
	AHU 3	$420	$68	$488	$73	$49	$610	$91	$701
	AHU 4	$359	$68	$427	$64	$43	$534	$80	$614
	AHU 5	$359	$68	$427	$64	$43	$534	$80	$614
	AHU 6	$292	$68	$360	$54	$36	$450	$67	$517
	AHU 7	$328	$68	$396	$59	$40	$495	$74	$569
	AHU 8	$359	$68	$427	$64	$43	$534	$80	$614
	EF 5	$366	$68	$434	$65	$43	$542	$81	$624
	CHW PUMP	$420	$68	$488	$73	$49	$610	$91	$701
	HW PUMP	$420	$68	$488	$73	$49	$610	$91	$701
	TOTAL								$6,979
514	AHU 3	$420	$68	$488	$73	$49	$610	$91	$701
	TOTAL								$701
522	CHWP	$359	$68	$427	$64	$43	$534	$80	$614
	HWP	$359	$68	$427	$64	$43	$534	$80	$614
	TOTAL								$1,227

INSTALL HIGH EFFICIENCY MOTORS

MOTORS OPERATING AT FULL LOAD (1800 RPM)				ELEC. COST: $0.0255 /kWH DEMAND COST: $8.85 /kW					
				HOURS OF OPERATION PER YEAR					
				2000 HRS		4000 HRS		8760 HRS	
H.P.	STANDARD EFFICIENCY	PREMIUM EFFICIENCY	DIFFERENTIAL COST *	SAVINGS/ YEAR	SIMPLE PAYBACK	SAVINGS/ YEAR	SIMPLE PAYBACK	SAVINGS/ YEAR	SIMPLE PAYBACK
1	77.0%	86.5%	$148	$14	10.6	$19	8.0	$29	5.0
1.5	77.0%	86.5%	$167	$21	8.0	$28	6.0	$44	3.8
2	80.0%	86.5%	$178	$18	9.7	$24	7.3	$39	4.6
3	84.0%	88.5%	$172	$18	9.7	$24	7.3	$38	4.6
5	85.5%	89.5%	$201	$25	7.9	$34	5.9	$54	3.7
7.5	86.5%	91.7%	$305	$48	6.4	$64	4.8	$102	3.0
10	87.5%	91.7%	$370	$51	7.3	$68	5.4	$108	3.4
15	88.5%	92.4%	$495	$70	7.1	$93	5.3	$148	3.3
20	90.2%	93.0%	$579	$65	8.9	$87	6.7	$138	4.2
25	90.2%	93.6%	$646	$98	6.6	$131	4.9	$208	3.1
30	90.2%	94.1%	$729	$134	5.4	$179	4.1	$285	2.6
40	91.0%	94.1%	$1,042	$141	7.4	$188	5.5	$299	3.5
50	91.7%	94.5%	$1,214	$157	7.7	$210	5.8	$334	3.6
60	91.7%	94.5%	$1,515	$189	8.0	$252	6.0	$401	3.8
75	92.2%	94.5%	$1,743	$193	9.0	$257	6.8	$409	4.3
100	93.0%	94.6%	$2,666	$177	15.0	$236	11.3	$376	7.1

* DIFFERENTIAL COST DOES NOT INCLUDE LABOR COSTS

ECO-15, SEPARATE (AUTOMATIC) LIGHT SWITCHES

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: MECO25
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.062
INSTALLATION & LOCATION: FT. McPHERSON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-15 SEPARATE SWITCHES FOR LIG
ANALYSIS DATE: 07-09-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	25267.
B. SIOH	$	1390.
C. DESIGN COST	$	1516.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	28173.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.47	160.	$ 1195.	15.61	18661.
B. DIST	$ .00	0.	$ 0.	21.66	0.
C. RESID	$ .00	0.	$ 0.	26.51	0.
D. NAT G	$ 4.67	-25.	$ -117.	23.77	-2775.
E. COAL	$ .00	0.	$ 0.	16.06	0.
F. TOTAL		135.	$ 1079.		$ 15885.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 1368.
(1) DISCOUNT FACTOR (TABLE A) 14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 19877.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 19877.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 5242.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) .75
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 2447.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 35762.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.27
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 11.51

SEPARATE LIGHT SWITCHES SAMPLE CALCULATION, ECO #15
BUILDING 184, ROOM 6

Given:

# of Fixtures	= 2 fixture	- from survey notes
Fixture Type	= 4x2 4-lamp fluorescent	- from survey notes
Watts / Fixture	= 155 W / fixture	- from manufacturer info
Percent Lighting Savings	= 19%	- average for all bldgs
Hours On / Year	= 3,393 hrs / yr	- from bldg occupancy
Gas Increase Factor	= 5.4E-4 MBtu / kWh	- from computer simulation
Electric Savings Factor	= 0.17 kWh / kWh	- from computer simulation
Gas Cost	= $4.67 / MBtu	- from utility rate analysis
Electric Cost	= $0.0255 / kWh	- from utility rate analysis
Demand Cost	= $8.85 / kW	- from utility rate analysis

Existing Lighting Demand:

(2 fixtures)*(155 W / fixture) = 0.31 kW

Peak Demand Savings:

(0.31 kW)*(0.19) = 0.06 kW

Annual Energy Savings:

Electric:
Lighting:
(0.06 kW)*(3,393 hrs / yr) = 200 kWh / yr
Cooling:
(200 kWh)*(0.17 kWh / kWh) = 34 kWh / yr
Total:
200 + 34 kWh / yr = 234 kWh / yr
Gas:
(200 kWh /yr)*(5.4E-4 MBtu / kWh) = 0.1 MBtu / yr

Annual Cost Savings:

(234 kWh)*($0.0255 / kWh) + (0.06 kW)*($8.85 / kW)*(4 + .95 * 8) - (0.1 MBtu)*($4.67 / MBtu) = $12.08 / yr

Estimated Construction Cost:

$65.11 / wall sensor - from engineer's cost estimate

($65.11 / ea)*(1 sensor) = $65

$65 + ($65 * .055 SIOH) + ($65 * .055 DESIGN) = $72

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON
ECO: 15, SEPARATE SWITCHES TO CONTROL LIGHTING

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 07/17/92
FILE: MLITSIR.WK3
PRPARED BY: CAMERAN DIBAI
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
INCREMENTAL GAS COST	$4.67 MBtu	23.77 UPWG
INCREMENTAL ELECTRIC COST	$0.0255 kWh	15.61 UPWE
ELECTRIC DEMAND CHARGE	$102.66 kW	14.53 UPW
ECONOMIC LIFE	25 YRS	

ESTIMATED 8760 HOURS OF LIGHTING PER YEAR

BLDG	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWH)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS ($)	ANNUAL DEMAND SAVINGS ($)	ANNUAL NON-ENERGY SAVINGS ($)	TOTAL ANNUAL SAVINGS ($)	CONST. COST ($)	SIR	SIMPLE PAYBACK (YRS)
41	0.85	3,415	−0.63	11	$84	$87	$0.00	$171	$1,358	1.9	7.9
101	2	7,464	−1.38	24	$184	$205	$0.00	$389	$3,401	1.7	8.7
401	0.28	1,946	−0.36	6	$48	$29	$0.00	$77	$669	1.7	8.7
246	2.1	8,407	−3.13	26	$200	$216	$0.00	$415	$4,313	1.4	10.4
170	1.45	9,446	−1.39	31	$234	$149	$0.00	$383	$4,338	1.3	11.3
366	0.076	257	−0.49	0	$4	$8	$0.00	$12	$167	1.0	13.9
171	6.57	15,922	−17.8	37	$323	$674	$0.00	$997	$13,926	1.0	14.0
TOTAL	13.326	46,857	−25.18	134.743	1077.26	1368	0	2445.3	$28,173	1.3	11.5

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

EFFECTIVE PRICING DATE APR 92

DATE PREPARED 16-Apr-92

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

X CODE A ☐ CODE B ☐ CODE C ☐ OTHER

DRAWING NO.

SHT OF

ESTIMATOR RMG

CHECKED BY CEL

INDIVIDUAL OFFICES: SINGLE LEVEL LIGHTING CONTROL FROM OCCUPANCY SENSORS	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
#W-120A IFRARED SENSOR	1	EA	0.25	0.25	$21.17	$5.29			$40.00	$40.00	$45.29		
SUBTOTAL						$5.29				$40.00	$45.29		
OVERHEAD, BOND	15%					$0.79				$6.00	$6.79		
PROFIT	10%					$0.53				$4.00	$4.53		
COST SUB-TOTAL						$6.62				$50.00	$56.62		
CONTINGENCY	15%					$0.99				$7.50	$8.49		
TOTAL						$7.61				$57.50	$65.11		

DA FORM 5418-R, APR 85

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study
LOCATION Ft. McPherson & Ft Gillem

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097
X CODE A ☐ CODE B ☐ CODE C ☐ OTHER ______

EFFECTIVE PRICING DATE APR 92
DRAWING NO.
ESTIMATOR RMG

DATE PREPARED 16-Apr-92
SHT OF
CHECKED BY CEL

INDIVIDUAL OFFICES: SINGLE LEVEL LIGHTING CONTROL FROM OCCUPANCY SENSORS	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
#W 1000A-ULTRASONIC SENSOR	1	EA	3.31	3.31	$21.17	$70.07			$85.00	$85.00	$155.07		
POWER PACK #A277D	1	EA	0.95	0.95	$21.17	$20.11			$25.00	$25.00	$45.11		
REMOVE WALL SWITCH/WIRING	1	EA	0.95	0.95	$21.17	$20.11			$8.00	$8.00	$28.11		
SENSOR WIRING/CONNECTIONS	1	EA	0.48	0.48	$21.17	$10.16			$20.00	$20.00	$30.16		
SUBTOTAL						$120				$138	$258		
OVERHEAD, BOND	15%					$18				$21	$39		
PROFIT	10%					$12				$14	$26		
COST SUB-TOTAL						$151				$173	$323		
CONTINGENCY	15%					$23				$26	$48		
TOTAL						$173				$198	$372		

DA FORM 5416-R, APR 85

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 21-91-C-0097

[X] CODE A [ ] CODE B [ ] CODE C [ ] OTHER ________

EFFECTIVE PRICING DATE APR 92

DATE PREPARED 22-Apr-92

DRAWING NO.

SHT OF

ESTIMATOR RMG

CHECKED BY CEL

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft Gillem

ELECTRICAL REWIRING FOR MULTIPLE LIGHT SWITCHING (LINE VOLTAGE)	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
ADD LIGHT SWITCH													
SWITCH AND COVERPLATE	1	EA	0.4	0.4	$21.17	$8.47			$6.45	$6.45	$14.92		
OUTLET BOX AND EXT. RING	1	EA	0.55	0.55	$21.17	$11.64			$4.65	$4.65	$16.29		
MOUNT SWITCHBOX, PATCH AND REPAIR	1	EA	3	3	$21.17	$63.51			$20.00	$20.00	$83.51		
5.5' DRYWALL, PLASTER, PAINT													
CONDUIT AND WIRE	0.2	CLF	6.15	1.23	$21.17	$26.04			$47.00	$9.40	$35.44		
CONNECTIONS AT CEILING LIGHT	1	EA	0.5	0.5	$21.17	$10.59			$3.00	$3.00	$13.59		
WIREMOLD SURFACE METAL RACEWAY	5	LF	0.8	4	$21.17	$84.68			$0.47	$2.35	$87.03		
SWITCHBOX AND SWITCH	1	EA	0.7	0.7	$21.17	$14.82			$10.00	$10.00	$24.82		
SUBTOTAL						$219.74				$55.85	$275.59		
OVERHEAD, BOND	15%					$32.96				$8.38	$41.34		
PROFIT	10%					$21.97				$5.59	$27.56		
COST SUB-TOTAL						$274.68				$69.81	$344.49		
CONTINGENCY	15%					$41.20				$10.47	$51.67		
TOTAL						$315.88				$80.28	$396.17		

DA FORM 5416-R, APR 85

TheWatt Stopper

Passive Infrared Wall Switch

- Simply replaces existing light switches
- Large 1000 sq. ft. of coverage
- Built-in light level sensor
- Adjustable Sensitivity & Time Delay
- Advanced transformer/latching relay design
- Compatible with Electronic Ballasts
- Proven 30% to 70% savings
- Available in 24VDC and 24V Half Wave
- Three-year warranty; UL Listed

System Information

The Watt Stopper WI sensors simply replace existing wall switches and turn lighting systems on only when offices, conference rooms, copy rooms or utility rooms are actually occupied. Lighting systems are automatically turned off after the controlled area is left unoccupied for a user-specified length of time. When the area is used again, the lights are automatically turned on. Savings of 30% to 70% are common.

Sensor Operation

Watt Stopper WI sensors use advanced passive infrared technology to detect occupancy. With a patented, four-level, multiple cell viewing lens, the WI sensors are able to detect the difference between the infrared emissions from a human body and the background space. When no changes in infrared energy are detected for a user specified length of time (adjustable from 30 seconds to 20 minutes), the lighting systems are switched off.

Advanced Light-Level Sensing

WI-Series sensors also offer integrated light level sensing. Simply put, if the room is unoccupied and lighting systems are OFF, WI-wall switch sensors will not turn all or part of the lighting systems ON if a user-specified level of natural light already exists. A user can simply override this feature by placing his hand over the sensor for a second. This feature will save even more energy in areas with abundant natural light.

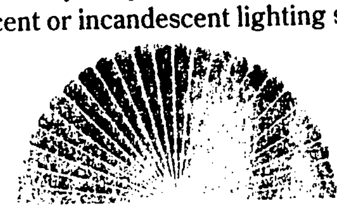
Design

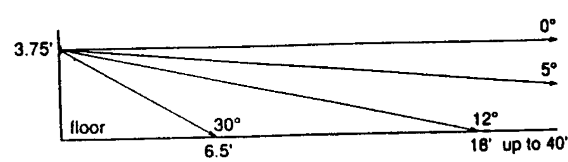
WI sensors use a unique transformer and latching-relay system which allows them to work with solid state ballasts and PL lamp systems. They feature a "no-visible screws" low-profile design and an easy OFF/override. For two-gang boxes the WI sensor requires the ASP-111 for blank cover options or the ASP-112 for two level switching.

Applications and Economics

Their expansive 1000 sq. ft. of coverage, adjustable time delay, adjustable sensitivity, advanced viewing lens and built-in light level sensor make WI-series sensors highly configurable and able to handle almost any lighting situation. Due to their competitive price, low installation costs and adjustability, these sensors offer extremely fast payback rates.They are perfect for offices, utility rooms, conference rooms or any area with fluorescent or incandescent lighting systems.

The Watt Stopper, Inc.
Santa Clara, CA 95050
TEL: (408) 988-5331
FAX: (408) 988-5373
Plano, TX 75023
1-800-879-8585



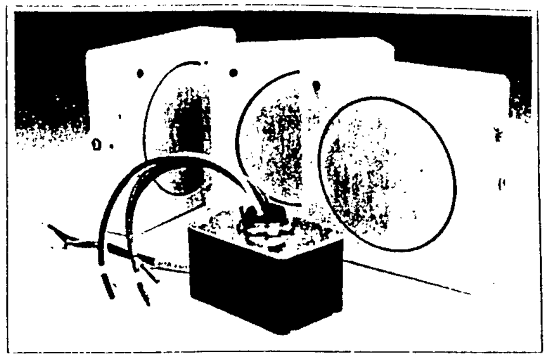


WI sensors use a patented viewing [illegible] with a four-level pattern which eliminates mounting height problems and insures accurate detectio

The Watt Stopper

Ultrasonic Sensors

- Proven 30% to 60% savings; Turn lights on only when needed
- 500, 1000 and 2000 sq. ft. coverages available
- Adjustable sensitivity & time delay
- Fully-integrated product line
- UL Listed; Three-year warranty



Complete Systems Integration

Watt Stopper Ultrasonic Sensors are part of an integrated system of lighting control products. Sensors are available to control almost any application, and can work as stand-alone products or as part of a larger lighting control system.

Operation

Watt Stopper Ultrasonic Sensors utilize advanced omni-directional ultrasonic doppler technology to sense occupancy. When ceiling mount sensors detect movement in controlled areas, they switch lighting systems on through a Watt Stopper Power Pack. The sensor controls the power pack through low-voltage wiring. As long as movement is sensed, the lights remain on. Lighting systems are switched off when no movement is detected in a user-adjustable period of time (from 15 seconds to 15 minutes).

Features

Watt Stopper Ultrasonic Sensors are designed to work across a wide variety of applications, both individually and as part of a larger system. All Watt Stopper Ultrasonic sensors feature adjustable time delay (from 15 seconds to 15 minutes), adjustable sensitivity, logic key/ON bypass and omni-directional ultrasonic technology. An LED indicator makes sensitivity adjustments easier. In addition, Watt Stopper Ultrasonic sensors are UL Listed and have a three-year warranty.

Applications

Ultrasonic sensors come in coverages of 500 sq. ft., 1000 sq. ft. and 2000 sq. ft. They're designed to work together to effectively control small offices, utility areas, open office spaces and even warehouses. The W-500A is perfect for offices, conference rooms, bathrooms and other areas up to 500 sq. ft. The W-1000A is ideal for larger spaces like classrooms and storage areas. The W-2000H is ideal for hallways, while the W-2000A is ideal for large open areas such as warehouses and can control partitioned open office spaces when configured in highly-versatile zone patterns. The W-120C and W-277C are wall switch replacement units that are ideal for small storage areas, bathrooms and enclosed rooms. All the units are designed to pick up people reaching for phones, writing, typing, etc.

Economics

Watt Stopper Ultrasonic Sensors slash utility costs by turning lights off when they're not needed. And, unlike sweep systems, they don't impair the work environment in any way. Also, easy installation and low initial cost provide fast paybacks.

- Solid State, crystal-controlled (25 KHZ± .005)
- Omni-directional transmission (360° coverage)
- Temperature and humidity-resistant 25 KHZ Microphone Receivers
- Logic Key/ON bypass
- 4.5" x 4.5" x 1.25" (115mm x 115mm x 32mm) (W x L x D)
- Available in White or Ivory

The Watt Stopper, Inc.
Santa Clara, CA 95050
TEL: (408) 988-5331
FAX: (408) 988-5373
Plano, TX 75023
1-800-879-8585

WI Sensor Technical Information

WI Sensor Specifications

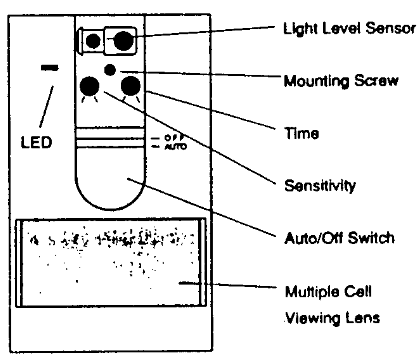
- Part of a completely integrated line of lighting control products
- Coverage: covers a 180° area — 40 foot range with adjustment
- Auto/OFF time delay adjustable from 30 seconds to 20 minutes
- Adjustable unit sensitivity
- Integrated light level sensor — works from 5 to 400 footcandles
- Red LED display to indicate detection
- Advanced transformer/latching relay design for WI-120A & WI-277A
- Works with solid-state ballasts and PL type lamps
- No leakage current in off mode — Patent Pending
- Small size — 2.8" x 4.8" x 1" (72mm x 122mm x 26mm)
- Voltage drop protection — Patent Pending
- Integrated four level fresnel lens — Patent Pending
- Three-year warranty; UL Listed
- Available in Tamper Proof Model, and in White or Ivory

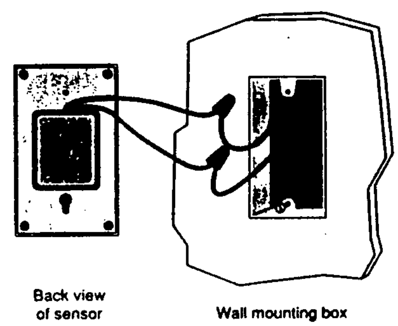
Ordering Information

Catalog No.	Coverage	Voltage	Load Requirements	Notes
WI-120A	1000 sq. ft.	120 VAC	50-600 Watts	1
WI-277A	1000 sq. ft.	277 VAC	50-1000 Watts	1
WI-24	1000 sq. ft.	24 VDC	Two 24 VDC outputs	1,2
WI-R7P	1000 sq. ft.	24 VDC halfwave	Three RR7 Relays	1,3
ASP-111	Blank plate for Two Gang Box			1
ASP-112	Switch Plate Cover-Dual Switch			1

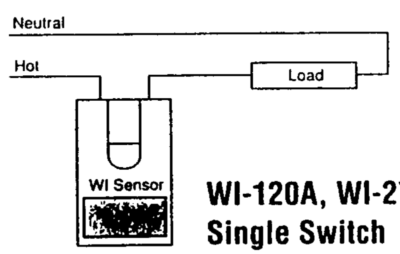
Notes: *1 – Add a **TP** to Catalog No. for Tamper Proof, and add a **W** for White or **I** for Ivory
*2 – Used with Watt Stopper Power Packs
*3 – For half-wave pulse, low-voltage lighting systems

Product Controls and Installation

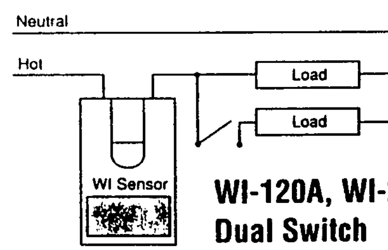




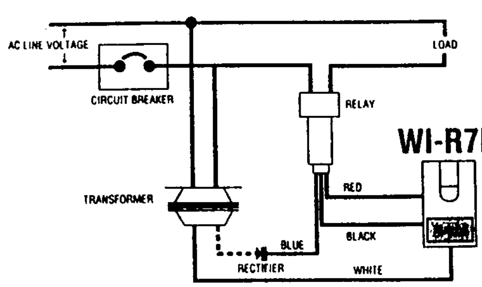
Circuit Schematics



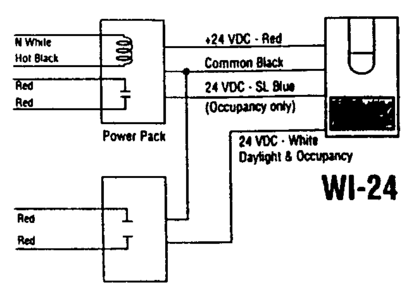
WI-120A, WI-277A Single Switch



WI-120A, WI-277A Dual Switch
(Requires ASP-112)



WI-R7P



WI-24

The Watt Stopper, Inc.
Santa Clara, CA 95050
Pub. No. 0302

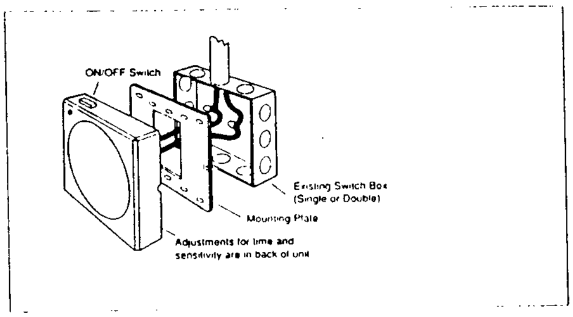
Ultrasonic Sensor Technical

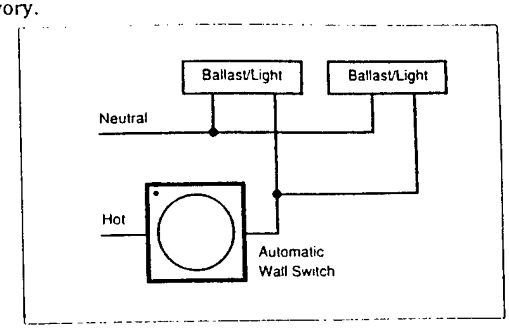
rdering Information

Catalog No.	Description/Type	Voltage	Current/Load	Coverage	Load Requirements
W-120C	Wall Switch	120 VAC	150-800 Watts	500 sq.ft. - 180°	
W-277C	Wall Switch	277 VAC	150-1000 Watts	500 sq.ft. - 180°	
W-500A	Ceiling Sensor	24 VDC	20 ma	500 sq.ft. - 360°	1, 2*
W-1000A	Ceiling Sensor	24 VDC	20 ma	1000 sq.ft. - 360°	1, 2*
W-2000A	Ceiling Sensor	24 VDC	20 ma	2000 sq.ft. - 360°	1, 2*
W-2000H	Hallway Sensor	24 VDC	20 mA	1000 sq.ft. **	1, 2*

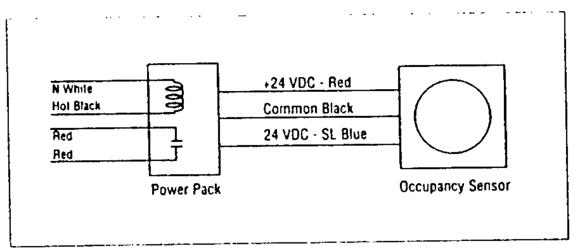
*1 - Used with Watt Stopper Power Packs.
*2 - Available for Half-wave pulse, low-voltage lighting systems. Add "-24" to Catalog No.
Note: Standard models are White, add an I to Catalog No. for Ivory.

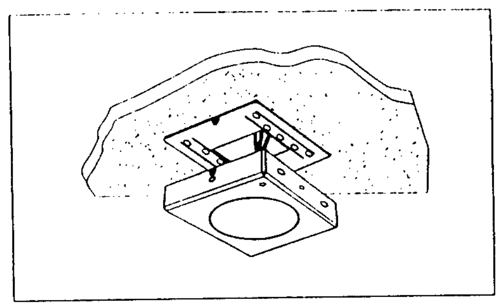
Wall Switch Placement and Schematic

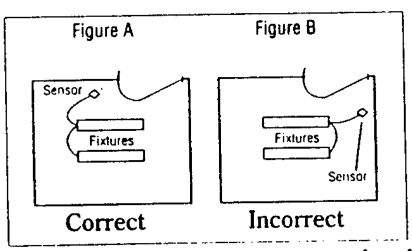




Ceiling Sensor Placement and Schematic

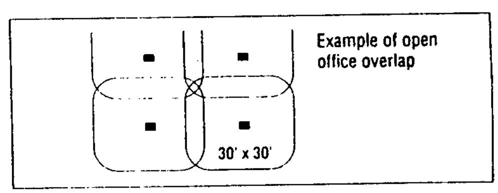




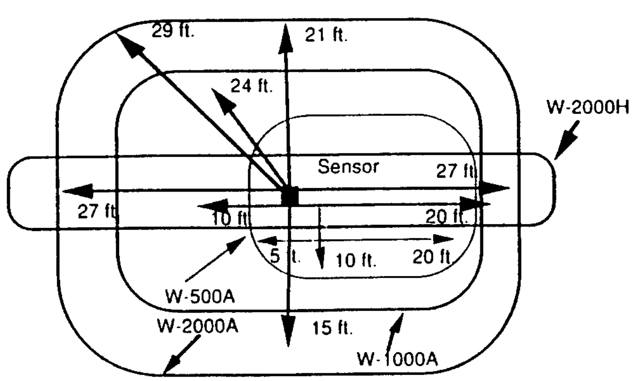


For enclosed spaces sensors should be placed as in Figure A. Sensors placed as in Figure B would see out the door, resulting in false triggering.

For standard installation use toggle bolts attaching mounting plate to ceiling tile. Always try to attach sensor to a vibration free surface.



Ceiling Sensor Coverage



For open office space the W-2000A is the most often used because of its true 360° coverage and capability to bounce off of partitions, walls, floors and other reflecting objects to sense motion. A typical layout for open office space is for the ultrasonic sensors to control the office area in zones that overlap. The coverage can be for a 20' x 20' zone and up to a maximum of 40' x 40'. A typical zone is about 25' x 25' for the lighting fixtures and an overlap on the sensor coverage that picks up to 30' x 30'.

**The W-2000H drawing is not drawn to scale. Coverage is 10' x 100' in a hallway, walls are

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 21-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 41LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 4

BUILDING NUMBER: 41

Sheet 1 of 1

Schedule #1	M-F	600 to	1900	S-S	0 to	0
Schedule #2	M-F	0 to	0	S-S	0 to	0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
1	2	4x2-4 lamp fluorescent	off	yes	yes	2	no
2	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
3	4	4x2-4 lamp fluorescent	on	yes	no	1	no
4	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
5	4	4x2-4 lamp fluorescent	on	yes	yes	2	no
6	5	4x2-2 lamp fluorescent	on	yes	no	2	no
7	2	4x2-4 lamp fluorescent	on	yes	no	1	no
8	6	4x2-4 lamp fluorescent	off	yes	no	1	no
9	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
10	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
11	1	4x2-4 lamp fluorescent	on	yes	no	2	no
12	20	4x2-4 lamp fluorescent	off	yes	no	2	no
13	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
14	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
15	1	4x2-2 lamp fluorescent	on	yes	yes	1	no
16	1	4x2-2 lamp fluorescent	on	yes	yes	1	no
17	1	4x2-2 lamp fluorescent	off	yes	yes	1	no
18	4	4x2-4 lamp fluorescent	off	yes	no	1	no
19	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
20	4	4x2-4 lamp fluorescent	on	yes	no	1	no
21	6	4x2-4 lamp fluorescent	on	yes	no	1	no
22	3	4x2-2 lamp fluorescent	on	yes	no	1	no
23	5	4x2-4 lamp fluorescent	on	yes	no	2	no
24	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
25	2	4x2-4 lamp fluorescent	off	yes	yes	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 21-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 41LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 41

Sheet 1 of 1

% Unnoc. lights: 19%
Gas Increase Factor 2.20E-04 MBtu/kWh
Cooling Factor (Energy) 1.19

Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches: No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
1	0.31	3393	0.06	200	0.044	238	0	$0.00	YES	$65.11	NO	$0.00
2	0.31	3393	0.06	200	0.044	238	0	$0.00	YES	$65.11	NO	$0.00
3	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
4	0.47	3393	0.09	300	0.066	357	0	$0.00	YES	$65.11	NO	$0.00
5	0.62	3393	0.12	400	0.088	476	0	$0.00	NO	$0.00	YES	$372.00
6	0.45	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
7	0.31	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
8	0.93	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
9	0.31	3393	0.06	200	0.044	238	0	$0.00	YES	$65.11	NO	$0.00
10	0.31	3393	0.06	200	0.044	238	0	$0.00	YES	$65.11	NO	$0.00
11	0.16	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
12	3.10	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
13	0.47	3393	0.09	300	0.066	357	0	$0.00	YES	$65.11	NO	$0.00
14	0.47	3393	0.09	300	0.066	357	0	$0.00	YES	$65.11	NO	$0.00
15	0.09	3393	0.02	57	0.013	68	0	$0.00	YES	$65.11	NO	$0.00
16	0.09	3393	0.02	57	0.013	68	0	$0.00	YES	$65.11	NO	$0.00
17	0.09	3393	0.02	57	0.013	68	0	$0.00	YES	$65.11	NO	$0.00
18	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
19	0.31	3393	0.06	200	0.044	238	0	$0.00	YES	$65.11	NO	$0.00
20	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
21	0.93	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
22	0.27	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
23	0.78	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
24	0.31	3393	0.06	200	0.044	238	0	$0.00	YES	$65.11	NO	$0.00
25	0.31	3393	0.06	200	0.044	238	0	$0.00	YES	$65.11	NO	$0.00
Total	13.224		0.84588	2870.071	0.63142	3415.384	0	$0.00		$846.43		$372.00
			Total $ Expense =	$1,218.43								

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 21-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 101LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 12

BUILDING NUMBER: 101

Sheet 1 of 1

Schedule #1	M-F	700 to	1850	S-S	0 to	0
Schedule #2	M-F	0 to	0	S-S	0 to	0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
1	3	4x2-4 lamp fluorescent	off	yes	yes	1	no
2	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
3	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
4	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
5	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
6	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
7	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
8	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
9	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
10	4	4x2-4 lamp fluorescent	on	yes	no	1	no
11	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
12	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
13	4	4x2-4 lamp fluorescent	on	yes	no	1	no
14	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
15	6	4x2-4 lamp fluorescent	on	yes	yes	1	no
16	6	4x2-4 lamp fluorescent	on	yes	no	1	no
17	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
18	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
19	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
20	4	4x2-4 lamp fluorescent	on	yes	no	1	no
21	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
22	9	4x2-4 lamp fluorescent	on	yes	no	2	no
23	3	4x2-4 lamp fluorescent	off	yes	no	1	no
24	1	4x2-4 lamp fluorescent	off	yes	no	1	no
25	4	4x2-4 lamp fluorescent	on	yes	no	1	no
26	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
27	7	8'-2 lamp fluorescent	on	yes	no	2	no
28	3	8'-2 lamp fluorescent	on	yes	no	1	no
29	4	4x2-2 lamp fluorescent	on	yes	no	1	no
30	4	4x2-2 lamp fluorescent	on	yes	no	1	no
31	7	4x2-2 lamp fluorescent	on	yes	no	1	yes
32	1	4x2-2 lamp fluorescent	on	yes	no	1	no
34	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
35	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
36	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
37	3	4x2-4 lamp fluorescent	on	yes	no	1	no
38	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
39	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
40	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
41	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
42	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
43	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
44	2	4x2-4 lamp fluorescent	on	yes	yes	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 21–Apr–92

ECO:15–LIGHTING CONTROL

FILE: 101LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21–91–C–0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 101

% Unnoc. lights: 19%
Gas Increase Factor 2.20E–04 MBtu/kWh
Cooling Factor (Energy) 1.19

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
1	0.47	3132	0.09	277	0.061	329	0	$0.00	YES	$65.11	NO	$0.00
2	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
3	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
4	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
5	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
6	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
7	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
8	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
9	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
10	0.62	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
11	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
12	0.62	3132	0.12	369	0.081	439	0	$0.00	NO	$0.00	YES	$372.00
13	0.62	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
14	0.47	3132	0.09	277	0.061	329	0	$0.00	YES	$65.11	NO	$0.[illegible]
15	0.93	3132	0.18	553	0.122	659	0	$0.00	NO	$0.00	YES	$372.[illegible]
16	0.93	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
17	0.16	3132	0.03	92	0.020	110	0	$0.00	YES	$65.11	NO	$0.00
18	0.47	3132	0.09	277	0.061	329	0	$0.00	YES	$65.11	NO	$0.00
19	0.62	3132	0.12	369	0.081	439	0	$0.00	NO	$0.00	YES	$372.00
20	0.62	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
21	0.47	3132	0.09	277	0.061	329	0	$0.00	YES	$65.11	NO	$0.00
22	1.40	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
23	0.47	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
24	0.16	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
25	0.62	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
26	0.62	3132	0.12	369	0.081	439	0	$0.00	NO	$0.00	YES	$372.00
27	1.47	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
28	0.63	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
29	0.36	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
30	0.36	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
31	0.62	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
32	0.09	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
34	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
35	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
36	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
37	0.47	3132	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
38	0.16	3132	0.03	92	0.020	110	0	$0.00	YES	$65.11	NO	$0.00
39	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
40	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
41	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
42	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
43	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
44	0.31	3132	0.06	184	0.041	220	0	$0.00	YES	$65.11	NO	$0.00
Total	19.954		2.0026	6272.143	1.37987	7463.85	0	$0.00		$1,562.64		$1,488.00

Total $ Expense = $3,050.64

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 170LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 20

BUILDING NUMBER: 170

Schedule #1 M-F 700 to 2200 S-S 700 to 2200
Schedule #2 M-F 0 to 2400 S-S 0 to 2400

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
1	1	4x2-4 lamp fluorescent	off	yes	no	1	no
2	1	150 Watt Incandescent	off	yes	no	1	no
28	4	4x2-2 lamp fluorescent	off	yes	no	1	no
5	1	4x2-4 lamp fluorescent	on	yes	no	1	no
6	4	4x2-4 lamp fluorescent	on	yes	no	1	no
9	6	4x2-4 lamp fluorescent	on	yes	no	1	no
9	15	4x2-2 lamp fluorescent	on	yes	no	1	no
29	6	4x2-2 lamp fluorescent	on	yes	no	1	no
17	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
21	7	4x2-2 lamp fluorescent	on	yes	no	1	no
27	1	4x2-4 lamp fluorescent	on	yes	no	1	no
25	1	4x2-2 lamp fluorescent	on	yes	no	1	no
24	4	4x2-2 lamp fluorescent	on	yes	no	1	no
23	2	4x2-2 lamp fluorescent	on	no	no	0	no
22	4	4x2-2 lamp fluorescent	on	yes	no	1	no
18	4	4x2-4 lamp fluorescent	off	yes	no	1	no
15	7	4x2-2 lamp fluorescent	on	no	no	0	no
14	5	4x2-2 lamp fluorescent	on	no	no	0	no
3	6	4x2-2 lamp fluorescent	on	yes	no	1	no
30	7	4x2-4 lamp fluorescent	on	yes	no	1	no
31	3	4x2-4 lamp fluorescent	on	yes	no	1	no
34	2	4x2-4 lamp fluorescent	on	yes	no	1	no
37	2	4x2-4 lamp fluorescent	on	yes	no	2	no
38	1	4x2-4 lamp fluorescent	on	yes	no	1	no
41	1	4x2-4 lamp fluorescent	on	yes	no	1	no
40	1	4x2-4 lamp fluorescent	on	no	yes	0	no
55	6	4x2-4 lamp fluorescent	on	yes	no	1	no
54	2	4x2-4 lamp fluorescent	on	yes	no	1	no
58	4	4x2-2 lamp fluorescent	on	yes	no	1	no
53	7	4x2-4 lamp fluorescent	on	yes	no	1	no
59	3	4x2-2 lamp fluorescent	on	yes	no	1	no
61	2	4x2-2 lamp fluorescent	on	no	no	0	no
71	3	4x2-4 lamp fluorescent	on	yes	no	1	no
70	1	4x2-4 lamp fluorescent	on	yes	no	1	no
69	3	4x2-4 lamp fluorescent	on	yes	no	1	no
68	1	4x2-4 lamp fluorescent	on	yes	no	1	no
60	3	4x2-4 lamp fluorescent	on	yes	no	1	no
65	2	4x2-4 lamp fluorescent	on	yes	no	1	no
66	1	4x2-4 lamp fluorescent	on	no	no	0	no
67	1	4x2-4 lamp fluorescent	on	no	no	0	no
68	1	4x2-4 lamp fluorescent	on	no	no	0	no
64	1	4x2-4 lamp fluorescent	on	yes	no	1	no
100	1	4x2-2 lamp fluorescent	on	yes	no	1	no
81	2	4x2-4 lamp fluorescent	on	yes	no	1	no
80	1	4x2-2 lamp fluorescent	on	yes	yes	1	no
72	1	4x2-4 lamp fluorescent	on	yes	no	1	no
73	1	4x2-4 lamp fluorescent	on	yes	yes	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION:

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 170LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 170

Schedule #1 M-F 700 to 2200 S-S 700 to 2200
Schedule #2 M-F 0 to 2400 S-S 0 to 2400

Room No.	# of Lights	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
74	1	4x2-4 lamp fluorescent	on	yes	no	1	no
74	2	4x2-4 lamp fluorescent	on	yes	no	1	no
79	1	4x2-4 lamp fluorescent	on	yes	no	1	no
42	1	4x2-4 lamp fluorescent	on	yes	no	1	no
52	2	4x2-4 lamp fluorescent	on	yes	no	1	no
43	1	4x2-4 lamp fluorescent	off	yes	no	1	no
44	1	4x2-4 lamp fluorescent	on	yes	no	1	no
45	1	4x2-4 lamp fluorescent	on	yes	no	1	no
46	1	4x2-4 lamp fluorescent	on	yes	no	1	no
47	1	4x2-4 lamp fluorescent	on	yes	no	1	no
102	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
103	1	4x2-2 lamp fluorescent	off	yes	yes	1	no
104	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
106	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
108	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
109	1	4x2-2 lamp fluorescent	on	yes	yes	1	yes
110	3	4x2-2 lamp fluorescent	on	yes	yes	2	yes
111	1	4x2-2 lamp fluorescent	off	yes	no	1	no
112	1	4x2-4 lamp fluorescent	on	yes	yes	2	no
116	1	4x2-2 lamp fluorescent	on	yes	yes	1	no
118	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
119	1	150 Watt Incandescent	on	yes	yes	1	yes
120	6	4x2-4 lamp fluorescent	on	yes	yes	1	no
122	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
119A	2	4x2-2 lamp fluorescent	on	yes	yes	1	no
HALL-1	7	4x2-2 lamp fluorescent	on	yes	no	1	no
HALL-2	1	4x2-2 lamp fluorescent	on	yes	no	1	no
HALL-3	2	4x2-2 lamp fluorescent	on	yes	no	1	no
HALL-4	1	4x2-2 lamp fluorescent	on	yes	no	1	no
HALL-5	2	4x2-2 lamp fluorescent	on	yes	no	1	no
HALL-6	3	4x2-2 lamp fluorescent	on	yes	no	1	no
121-137	18	4x2-4 lamp fluorescent	on	yes	yes	1	no
140-144	5	4x2-4 lamp fluorescent	on	yes	no	1	yes
154	1	4x2-2 lamp fluorescent	off	yes	yes	1	no
145	2	4x2-2 lamp fluorescent	off	yes	yes	1	no
146	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
147	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
148	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
150	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
149	1	4x2-4 lamp fluorescent	off	yes	no	1	no
153	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECC15-LIGHTING CONTROL

FILE: 170LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 170

Sheet 1 of 2

% Unnoc. lights: 19%
Gas Increase Factor 1.68E-04 MBtu/kWh
Cooling Factor (Ene 1.145

							Cost of Switches						
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
1	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
2	0.15	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
28	0.36	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
5	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
6	0.62	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
9	0.93	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
9	1.34	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
29	0.53	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
17	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
21	0.62	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
27	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
25	0.09	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
24	0.36	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
23	0.18	5475	0.00	46	0.008	53	1	$396.17	NO	$0.00	NO	$0.00
22	0.36	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
18	0.62	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
15	0.62	5475	0.00	162	0.027	185	2	$792.34	NO	$0.00	NO	$0.00
14	0.45	5475	0.00	116	0.019	132	1	$396.17	NO	$0.00	NO	$0.00
3	0.53	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
30	1.08	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
31	0.47	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
34	0.31	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
37	0.31	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
38	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
41	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
40	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
55	0.93	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
54	0.31	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
58	0.36	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
53	1.08	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
59	0.27	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
61	0.18	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
71	0.47	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
70	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
69	0.47	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
68	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
60	0.47	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
65	0.31	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
66	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
67	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
68	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
64	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
100	0.09	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
81	0.31	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
80	0.09	5475	0.02	93	0.016	106	0	$0.00	YES	$65.11	NO	$0.00
72	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
73	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
				900.2585						$260.44		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECC15-LIGHTING CONTROL

FILE: 170LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 170

% Unnoc. lights: 19%
Gas Increase Factor 1.30E-03 MBtu/kWh
Cooling Factor (Ene 1.16

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
74	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
74	0.31	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
79	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
42	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
52	0.31	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
43	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
44	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
45	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
46	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
47	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
102	0.31	5475	0.06	322	0.054	369	0	$0.00	YES	$65.11	NO	$0.00
103	0.09	5475	0.02	93	0.016	106	0	$0.00	YES	$65.11	NO	$0.00
104	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
106	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
108	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
109	0.09	5475	0.02	93	0.016	106	0	$0.00	YES	$65.11	NO	$0.00
110	0.27	5475	0.05	278	0.047	318	0	$0.00	YES	$65.11	NO	$0.00
111	0.09	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
112	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
116	0.09	5475	0.02	93	0.016	106	0	$0.00	YES	$65.11	NO	$0.00
118	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
119	0.15	5475	0.03	156	0.026	179	0	$0.00	YES	$65.11	NO	$0.00
120	0.93	5475	0.18	967	0.163	1108	0	$0.00	NO	$0.00	YES	$372.00
122	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
119A	0.18	5475	0.03	185	0.031	212	0	$0.00	YES	$65.11	NO	$0.00
HALL-	0.62	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
HALL-	0.09	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
HALL-	0.18	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
HALL-	0.09	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
HALL-	0.18	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
HALL-	0.27	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
121-1	2.79	5475	0.53	2902	0.488	3323	0	$0.00	NO	$0.00	YES	$372.00
140-1	0.78	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
154	0.09	5475	0.02	93	0.016	106	0	$0.00	YES	$65.11	NO	$0.00
145	0.18	5475	0.03	185	0.031	212	0	$0.00	YES	$65.11	NO	$0.00
146	0.18	5475	0.03	185	0.031	212	0	$0.00	YES	$65.11	NO	$0.00
147	0.18	5475	0.03	185	0.031	212	0	$0.00	YES	$65.11	NO	$0.00
148	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
150	0.16	5475	0.03	161	0.027	185	0	$0.00	YES	$65.11	NO	$0.00
149	0.16	5475	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
153	0.31	5475	0.06	322	0.054	369	0	$0.00	YES	$65.11	NO	$0.00
Total	28.931		1.44761	8249.625	1.38594	9445.82	4	$1,584.68		$1,562.64		$744.00

Total $ Expense = $3,891.32

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 171LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 22

BUILDING NUMBER: 171

Schedule #1 M-F 700 to 1500 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
1	8	4x2-4 lamp fluorescent	on	yes	yes	1	no
1	13	2x2-2 U-Bulb fluorescent	on	yes	yes	1	no
2	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
3	15	8'-2 lamp fluorescent	on	yes	yes	2	no
4	2	8'-2 lamp fluorescent	on	yes	yes	1	no
5	2	8'-2 lamp fluorescent	on	yes	yes	1	no
103	10	4x2-4 lamp fluorescent	on	yes	yes	2	no
108	5	4x2-4 lamp fluorescent	off	yes	yes	2	no
109	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
101	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
107	5	4x2-4 lamp fluorescent	on	yes	yes	1	no
125	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
128	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
127	4	4x2-2 lamp fluorescent	on	yes	yes	1	no
126	4	4x2-2 lamp fluorescent	on	yes	yes	1	no
111	8	4x2-2 lamp fluorescent	on	yes	yes	1	no
106	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
102	2	4x2-4 lamp fluorescent	on	yes	yes	2	no
120	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
201	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
203	8	4x2-4 lamp fluorescent	on	yes	yes	3	no
202	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
205	2	4x2-2 lamp fluorescent	on	yes	yes	1	no
206	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
207	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
208	2	4x2-2 lamp fluorescent	on	yes	yes	1	no
209	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
212	3	4x2-2 lamp fluorescent	on	yes	yes	1	no
210	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
213	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
214	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
215	1	4x2-2 lamp fluorescent	on	yes	yes	1	no
217	1	4x2-2 lamp fluorescent	on	yes	yes	1	no
218	4	4x2-2 lamp fluorescent	on	yes	yes	1	no
219	4	4x2-2 lamp fluorescent	on	yes	yes	1	no
220	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
243	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
242	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
244	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
238	3	4x2-4 lamp fluorescent	on	yes	yes	2	no
240	6	4x2-2 lamp fluorescent	on	yes	yes	1	no
222	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
223	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
225	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
239	2	4x2-4 lamp fluorescent	on	yes	yes	2	no
228	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
229	2	4x2-4 lamp fluorescent	on	yes	yes	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION: FORT McPHERSON

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 171LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 171

Sheet 2 of 2

Schedule #1 M-F 700 to 1500 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Lights	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
230	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
231	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
227	30	4x2-2 lamp fluorescent	on	yes	yes	4	no
238	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
232	4	4x2-2 lamp fluorescent	on	yes	yes	1	no
234	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
233	4	4x2-2 lamp fluorescent	on	yes	yes	1	no
235	2	4x2-2 lamp fluorescent	on	yes	yes	1	no
237	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
104	10	4x2-4 lamp fluorescent	on	yes	yes	2	no
105	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
144	1	4x2-2 lamp fluorescent	on	yes	yes	1	no
143	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
112	4	4x2-2 lamp fluorescent	on	yes	yes	1	no
113	4	4x2-2 lamp fluorescent	on	yes	yes	1	no
114	4	4x2-2 lamp fluorescent	on	yes	yes	1	no
115	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
116	2	4x2-2 lamp fluorescent	on	yes	yes	1	no
123	1	4x2-2 lamp fluorescent	on	yes	yes	1	no
124	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
122	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
121	12	4x2-2 lamp fluorescent	on	yes	yes	1	no
135	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
117	10	4x2-2 lamp fluorescent	on	yes	yes	4	no
118	1	4x2-4 lamp fluorescent	on	yes	yes	1	no
136	1	4x2-2 lamp fluorescent	on	yes	yes	1	no
119	1	4x2-4 lamp fluorescent	on	yes	yes	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 171LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 171

% Unnoc. lights: 19%
Gas Increase Factor 1.30E-03 MBtu/kWh
Cooling Factor (Energy) 1.16

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
1	1.24	2088	0.24	492	0.640	571	0	$0.00	NO	$0.00	YES	$372.00
1	1.196	2088	0.23	474	0.617	550	0	$0.00	NO	$0.00	YES	$372.00
2	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
3	3.15	2088	0.60	1250	1.625	1450	0	$0.00	NO	$0.00	YES	$372.00
4	0.42	2088	0.08	167	0.217	193	0	$0.00	YES	$65.11	NO	$0.00
5	0.42	2088	0.08	167	0.217	193	0	$0.00	YES	$65.11	NO	$0.00
103	1.55	2088	0.29	615	0.799	713	0	$0.00	NO	$0.00	YES	$372.00
108	0.775	2088	0.15	307	0.400	357	0	$0.00	NO	$0.00	YES	$372.00
109	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
101	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
107	0.775	2088	0.15	307	0.400	357	0	$0.00	NO	$0.00	YES	$372.00
125	0.465	2088	0.09	184	0.240	214	0	$0.00	YES	$65.11	NO	$0.00
128	0.62	2088	0.12	246	0.320	285	0	$0.00	NO	$0.00	YES	$372.00
127	0.356	2088	0.07	141	0.184	164	0	$0.00	NO	$0.00	YES	$372.00
126	0.356	2088	0.07	141	0.184	164	0	$0.00	NO	$0.00	YES	$372.00
111	0.712	2088	0.14	282	0.367	328	0	$0.00	NO	$0.00	YES	$372.00
106	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
102	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
120	0.465	2088	0.09	184	0.240	214	0	$0.00	YES	$65.11	NO	$0.00
201	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
203	1.24	2088	0.24	492	0.640	571	0	$0.00	NO	$0.00	YES	$372.00
202	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
205	0.178	2088	0.03	71	0.092	82	0	$0.00	YES	$65.11	NO	$0.00
206	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
207	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
208	0.178	2088	0.03	71	0.092	82	0	$0.00	YES	$65.11	NO	$0.00
209	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
212	0.267	2088	0.05	106	0.138	123	0	$0.00	YES	$65.11	NO	$0.00
210	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
213	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
214	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
215	0.089	2088	0.02	35	0.046	41	0	$0.00	YES	$65.11	NO	$0.00
217	0.089	2088	0.02	35	0.046	41	0	$0.00	YES	$65.11	NO	$0.00
218	0.356	2088	0.07	141	0.184	164	0	$0.00	NO	$0.00	YES	$372.00
219	0.356	2088	0.07	141	0.184	164	0	$0.00	NO	$0.00	YES	$372.00
220	0.62	2088	0.12	246	0.320	285	0	$0.00	NO	$0.00	YES	$372.00
243	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
242	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
244	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
238	0.465	2088	0.09	184	0.240	214	0	$0.00	YES	$65.11	NO	$0.00
240	0.534	2088	0.10	212	0.275	246	0	$0.00	NO	$0.00	YES	$372.00
222	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
223	0.465	2088	0.09	184	0.240	214	0	$0.00	YES	$65.11	NO	$0.00
225	0.465	2088	0.09	184	0.240	214	0	$0.00	YES	$65.11	NO	$0.00
239	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
228	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
229	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
				9091.632						$2,083.52		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 171LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 171

Sheet 2 of 2

% Unnoc. lights: 19%
Gas Increase Factor 1.30E-03 MBtu/kWh
Cooling Factor (Energy) 1.16

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
230	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
231	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
227	2.67	2088	0.51	1059	1.377	1229	0	$0.00	NO	$0.00	YES	$372.00
238	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
232	0.356	2088	0.07	141	0.184	164	0	$0.00	NO	$0.00	YES	$372.00
234	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
233	0.356	2088	0.07	141	0.184	164	0	$0.00	NO	$0.00	YES	$372.00
235	0.178	2088	0.03	71	0.092	82	0	$0.00	YES	$65.11	NO	$0.00
237	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
104	1.55	2088	0.29	615	0.799	713	0	$0.00	NO	$0.00	YES	$372.00
105	0.62	2088	0.12	246	0.320	285	0	$0.00	NO	$0.00	YES	$372.00
144	0.089	2088	0.02	35	0.046	41	0	$0.00	YES	$65.11	NO	$0.00
143	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
112	0.356	2088	0.07	141	0.184	164	0	$0.00	NO	$0.00	YES	$372.00
113	0.356	2088	0.07	141	0.184	164	0	$0.00	NO	$0.00	YES	$372[illegible]
114	0.356	2088	0.07	141	0.184	164	0	$0.00	NO	$0.00	YES	$372.[illegible]
115	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
116	0.178	2088	0.03	71	0.092	82	0	$0.00	YES	$65.11	NO	$0.00
123	0.089	2088	0.02	35	0.046	41	0	$0.00	YES	$65.11	NO	$0.00
124	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
122	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
121	1.068	2088	0.20	424	0.551	491	0	$0.00	NO	$0.00	YES	$372.00
135	0.31	2088	0.06	123	0.160	143	0	$0.00	YES	$65.11	NO	$0.00
117	0.89	2088	0.17	353	0.459	410	0	$0.00	NO	$0.00	YES	$372.00
118	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
136	0.089	2088	0.02	35	0.046	41	0	$0.00	YES	$65.11	NO	$0.00
119	0.155	2088	0.03	61	0.080	71	0	$0.00	YES	$65.11	NO	$0.00
Total	34.598		6.57362	13725.72	17.8434	15921.8335	0	$0.00		$3,190.39		$9,300.00
				Total $ Expense =		$12,490.39						

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 246LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 21

BUILDING NUMBER: 246

Sheet 1 of 1

Schedule #1 M-F 600 to 1900 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
154	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
153	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
152	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
151	3	4x2-4 lamp fluorescent	on	yes	no	1	no
155	4	4x2-4 lamp fluorescent	on	yes	no	1	no
102	4	4x2-4 lamp fluorescent	on	yes	no	1	no
103	6	4x2-4 lamp fluorescent	on	yes	no	1	no
106	4	4x2-4 lamp fluorescent	off	yes	yes	1	no
107	58	4x2-4 lamp fluorescent	on	yes	no	10	no
148	16	4x2-4 lamp fluorescent	on	yes	no	2	yes
147	22	4x2-4 lamp fluorescent	off	yes	yes	1	no
149	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
146	16	4x2-4 lamp fluorescent	on	yes	no	4	no
144	12	4x2-4 lamp fluorescent	on	yes	no	2	no
143	6	4x2-4 lamp fluorescent	on	yes	yes	1	yes
142	4	4x2-4 lamp fluorescent	on	yes	no	1	no
141	4	4x2-2 lamp fluorescent	on	yes	yes	1	no
136	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
139	2	8'-2 lamp fluorescent	off	yes	no	1	no
138	2	8'-2 lamp fluorescent	off	yes	no	1	no
109	31	4x2-4 lamp fluorescent	on	yes	no	4	no
110	5	4x2-4 lamp fluorescent	on	yes	yes	1	yes
111	16	4x2-4 lamp fluorescent	on	yes	no	4	no
115	3	4x2-4 lamp fluorescent	on	yes	no	1	no
113	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
116	8	4x2-4 lamp fluorescent	on	yes	no	2	no
124	34	4x2-4 lamp fluorescent	on	yes	no	5	no
119	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
120	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
122	1	4x2-4 lamp fluorescent	off	yes	yes	1	yes
123	2	4x2-4 lamp fluorescent	on	yes	yes	2	no
125	4	4x2-4 lamp fluorescent	on	yes	no	1	no
126	2	4x2-4 lamp fluorescent	on	yes	no	1	no
134	24	4x2-4 lamp fluorescent	on	yes	no	4	no
133	1	4x2-4 lamp fluorescent	on	yes	no	1	no
132	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
131	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
130	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
128	4	4x2-4 lamp fluorescent	on	yes	no	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 246LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 246

Sheet 1 of 1

% Unnoc. lights: 19%
Gas Increase Factor 4.40E-04 MBtu/kWh
Cooling Factor (Energ 1.18

Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
154	0.62	3393	0.12	400	0.176	472	0	$0.00	NO	$0.00	YES	$372.00
153	0.31	3393	0.06	200	0.088	236	0	$0.00	YES	$65.11	NO	$0.00
152	0.31	3393	0.06	200	0.088	236	0	$0.00	YES	$65.11	NO	$0.00
151	0.47	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
155	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
102	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
103	0.93	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
106	0.62	3393	0.12	400	0.176	472	0	$0.00	NO	$0.00	YES	$372.00
107	8.99	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
148	2.48	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
147	3.41	3393	0.65	2198	0.967	2594	0	$0.00	NO	$0.00	YES	$372.00
149	0.16	3393	0.03	100	0.044	118	0	$0.00	YES	$65.11	NO	$0.00
146	2.48	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
144	1.86	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0[illegible]
143	0.93	3393	0.18	600	0.264	707	0	$0.00	NO	$0.00	YES	$372.[illegible]
142	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
141	0.36	3393	0.07	230	0.101	271	0	$0.00	NO	$0.00	YES	$372.00
136	0.31	3393	0.06	200	0.088	236	0	$0.00	YES	$65.11	NO	$0.00
139	0.42	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
138	0.42	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
109	4.80	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
110	0.78	3393	0.15	500	0.220	590	0	$0.00	NO	$0.00	YES	$372.00
111	2.48	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
115	0.47	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
113	0.62	3393	0.12	400	0.176	472	0	$0.00	NO	$0.00	YES	$372.00
116	1.24	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
124	5.27	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
119	0.62	3393	0.12	400	0.176	472	0	$0.00	NO	$0.00	YES	$372.00
120	0.62	3393	0.12	400	0.176	472	0	$0.00	NO	$0.00	YES	$372.00
122	0.16	3393	0.03	100	0.044	118	0	$0.00	YES	$65.11	NO	$0.00
123	0.31	3393	0.06	200	0.088	236	0	$0.00	YES	$65.11	NO	$0.00
125	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
126	0.31	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
134	3.72	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
133	0.16	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
132	0.47	3393	0.09	300	0.132	354	0	$0.00	YES	$65.11	NO	$0.00
131	0.47	3393	0.09	300	0.132	354	0	$0.00	YES	$65.11	NO	$0.00
130	0.47	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
128	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
Total	**51.106**		**2.09969**	**7124.248**	**3.13467**	**8406.613**	**0**	**$0.00**		**$520.88**		**$3,348.00**
Total $ Saved/Year	**$199.64**			**Total $ Expense =**		**$3,868.88**						

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 21-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 366LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 2

BUILDING NUMBER: 366

Schedule #1 M-F 600 to 1900 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
1	8	4x2-2 lamp fluorescent	off	yes	no	1	no
2	4	4x2-4 lamp fluorescent	off	yes	no	1	no
3	1	4x2-2 lamp fluorescent	off	yes	yes	1	no
2	6	4x2-2 lamp fluorescent	off	yes	no	1	no
4	8	4x2-2 lamp fluorescent	off	yes	no	1	no
5	2	4x2-4 lamp fluorescent	off	yes	yes	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 21-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 366LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 366

Sheet 1 of 1

% Unnoc. lights: 19%
Gas Increase Factor 1.90E-03 MBtu/kWh
Cooling Factor (Energy) 1

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
1	0.71	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
2	0.62	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
3	0.09	3393	0.02	57	0.109	57	0	$0.00	YES	$75.00	NO	$0.00
2	0.53	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
4	0.71	3393	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
5	0.31	3393	0.06	200	0.380	200	0	$0.00	YES	$75.00	NO	$0.00
Total	2.977		0.07581	257.2233	0.48872	257.2233	0	$0.00		$150.00		$0.00
				Total $ Expense =		$150.00						

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

ECO: 15–LIGHTING CONTROL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 22-Apr-92
FILE: 401LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

EXIT SIGNS: 8

BUILDING NUMBER: 401

Sheet 1 of 1

Schedule #1	M-F	600 to	2300	S-S	900 to	2200	
Schedule #2	M-F	0 to	0	S-S	0 to	0	

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
ENT	1	4x2-2 lamp fluorescent	on	no	no	0	no
1	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
2	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
1	1	4x2-2 lamp fluorescent	on	yes	yes	1	no
3	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
4	4	4x2-2 lamp fluorescent	on	yes	no	1	no
4	2	4x2-4 lamp fluorescent	on	yes	no	1	no
5	14	4x2-2 lamp fluorescent	on	yes	no	1	no
6	2	4x2-2 lamp fluorescent	on	no	no	0	no
7	30	4x2-2 lamp fluorescent	on	yes	no	1	no
8	1	4x2-2 lamp fluorescent	on	yes	no	1	no
8	1	4x2-4 lamp fluorescent	on	yes	no	1	no
9	1	4x2-4 lamp fluorescent	on	yes	no	1	no
10	1	4x2-2 lamp fluorescent	on	yes	no	1	no
10	3	4x2-4 lamp fluorescent	on	yes	no	1	no
LOCKER	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
OLD MECH.	2	4x2-2 lamp fluorescent	on	yes	yes	2	yes
PIN.MACH	6	4x2-2 lamp fluorescent	on	yes	no	1	yes
S1	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
S2	1	4x2-2 lamp fluorescent	on	yes	yes	1	yes
S2	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 401LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 401

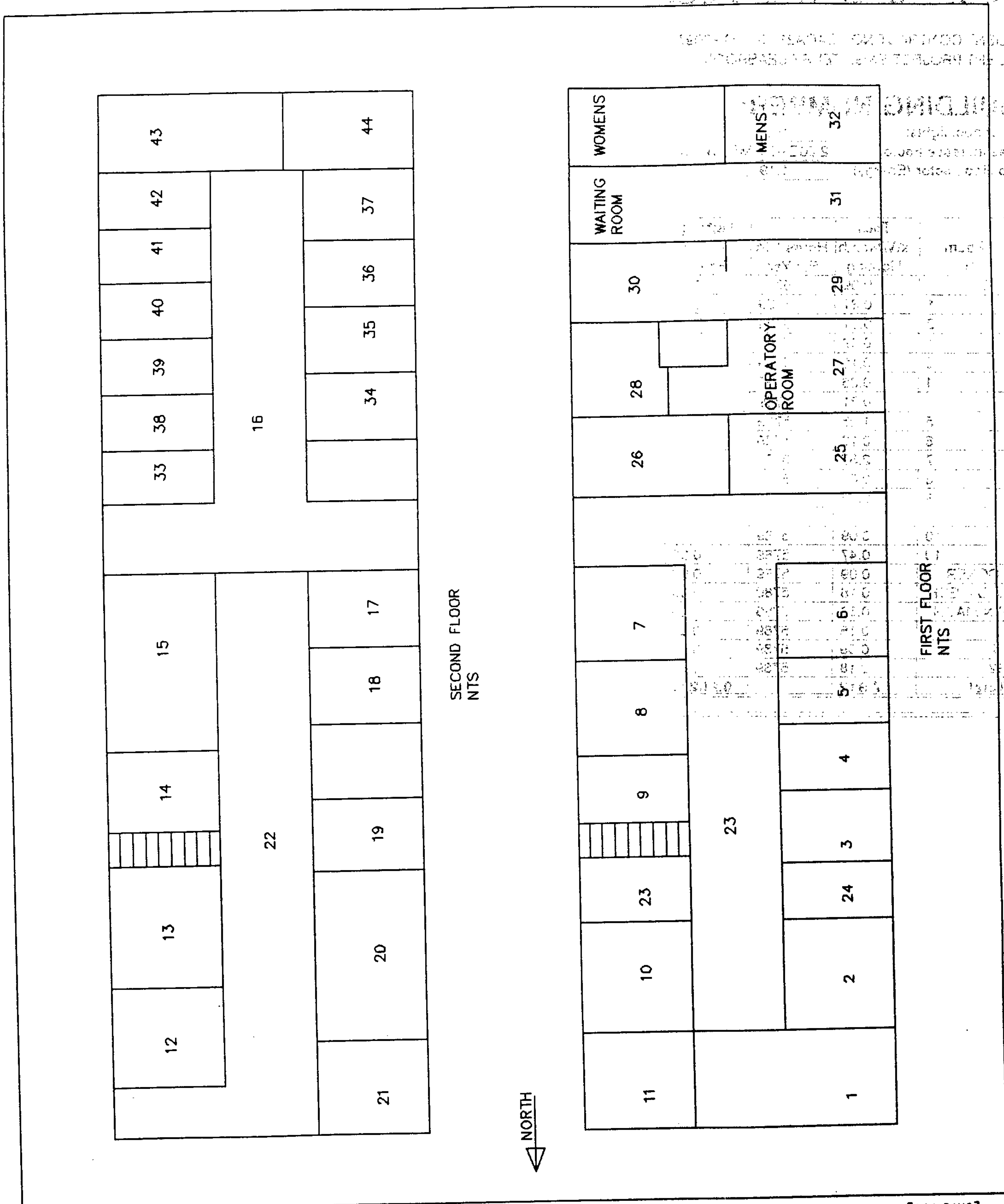
Sheet 1 of 1

% Unnoc. lights: 19%
Gas Increase Factor 2.20E-04 MBtu/kWh
Cooling Factor (Energy): 1.19

Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches: No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
ENT	0.09	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
1	0.31	5789	0.06	341	0.075	406	0	$0.00	YES	$65.11	NO	$0.00
2	0.31	5789	0.06	341	0.075	406	0	$0.00	YES	$65.11	NO	$0.00
1	0.09	5789	0.02	98	0.022	116	0	$0.00	YES	$65.11	NO	$0.00
3	0.16	5789	0.03	170	0.038	203	0	$0.00	YES	$65.11	NO	$0.00
4	0.36	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
4	0.31	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
5	1.25	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
6	0.18	5789	0.00	46	0.010	55	1	$396.17	NO	$0.00	NO	$0.00
7	2.67	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
8	0.09	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
8	0.16	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
9	0.16	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
10	0.09	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
10	0.47	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
LOCKER	0.09	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
OLD MECH.	0.18	5789	0.03	196	0.043	233	0	$0.00	YES	$65.11	NO	$0.00
PIN.MACH	0.53	5789	0.00	0	0.000	0	0	$0.00	NO	$0.00	NO	$0.00
S1	0.18	5789	0.03	196	0.043	233	0	$0.00	YES	$65.11	NO	$0.00
S2	0.09	5789	0.02	98	0.022	116	0	$0.00	YES	$65.11	NO	$0.00
S2	0.18	5789	0.03	196	0.043	233	0	$0.00	YES	$65.11	NO	$0.00
Total	**7.912**		**0.28253**	**1681.85**	**0.37001**	**2001.397**	**1**	**$396.17**		**$520.88**		**$0.00**

Total $ Expense = $917.05

EMC PROJECT # 3105.000
SHEET __ OF __
FT. MC PHERSON BLDG. 101



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EMC PROJECT # 3105.000
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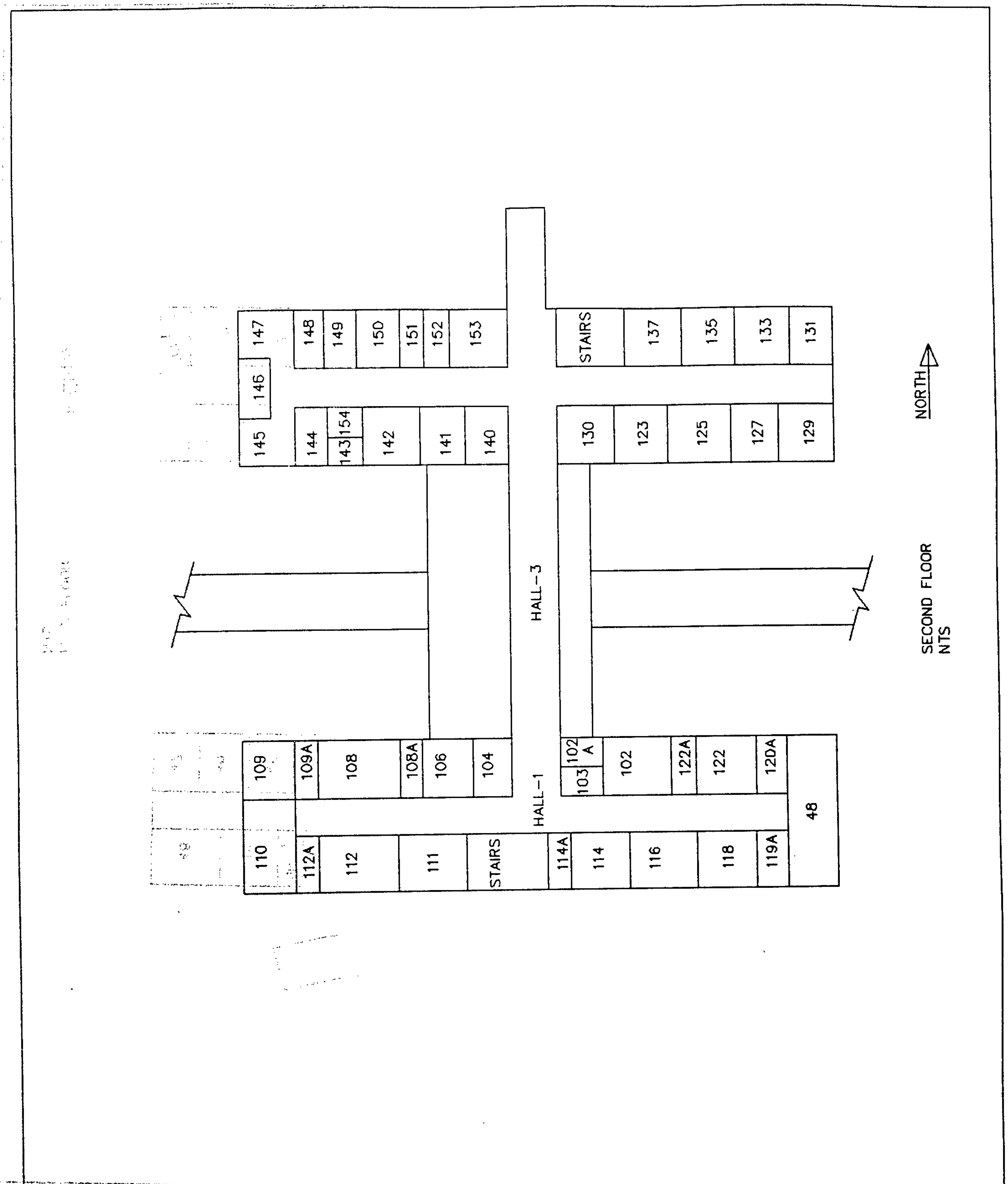

[170_2ND.DWG]

EMC PROJECT # 3105.000
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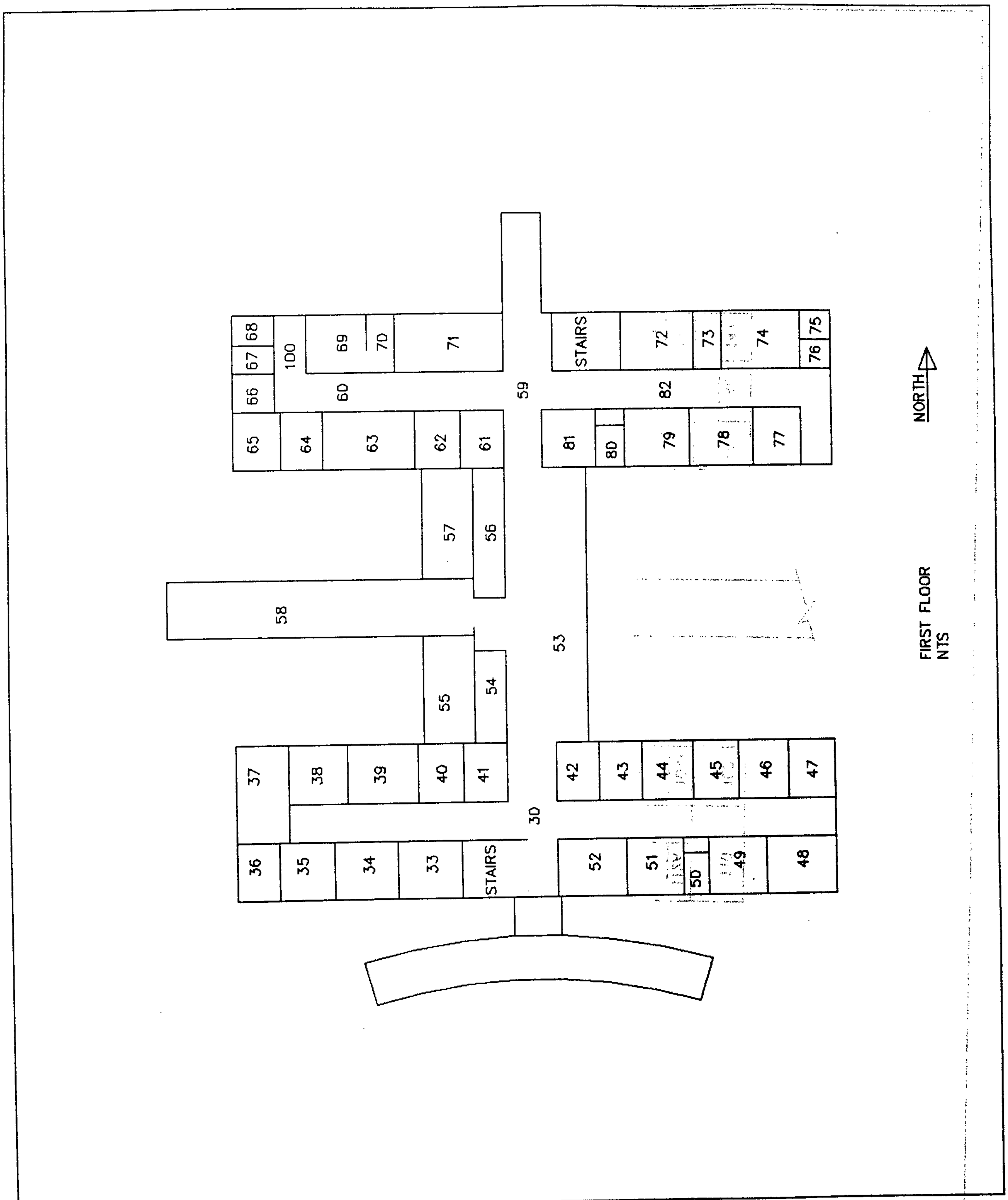

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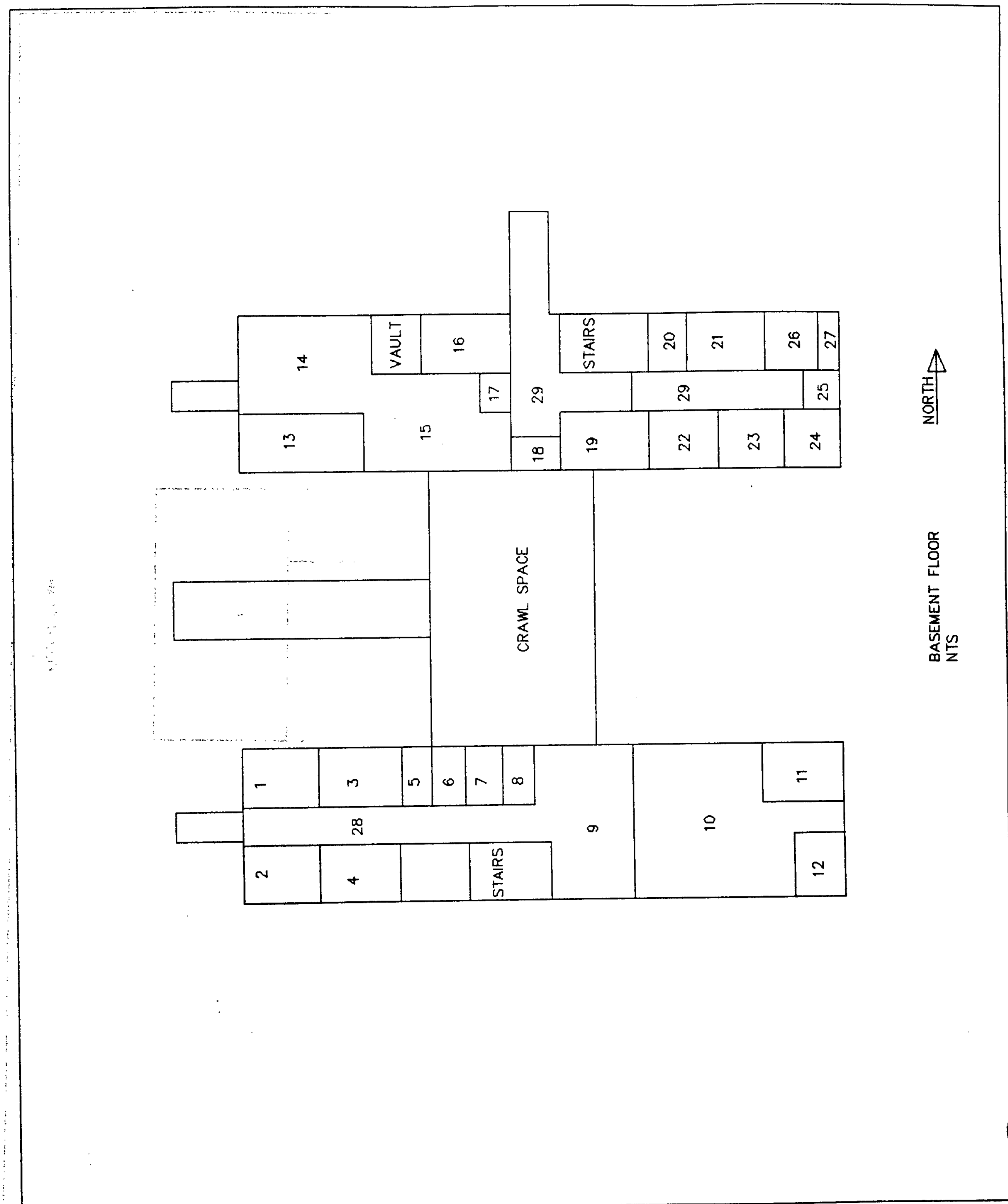

[170_BASE.DWG]

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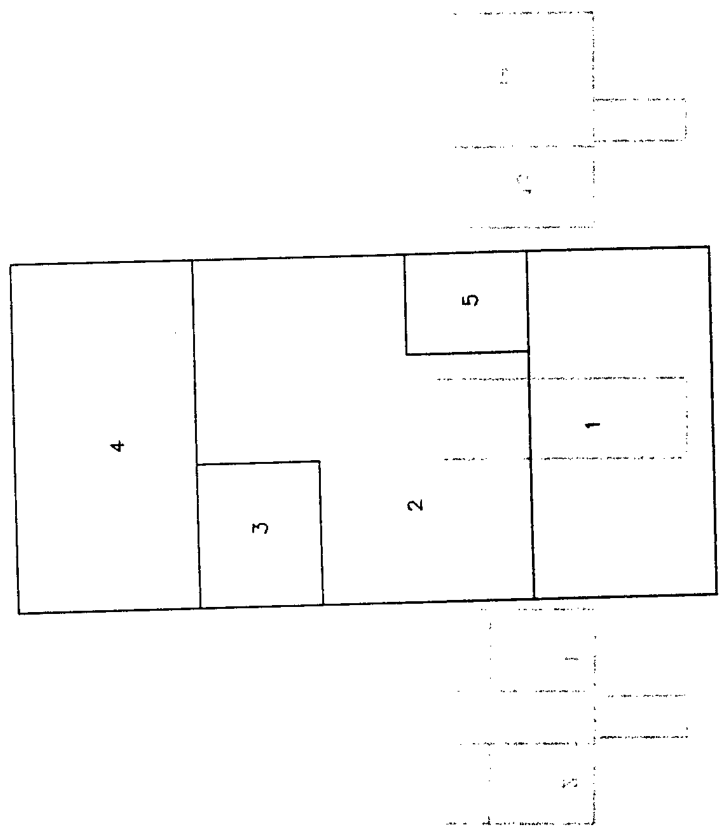
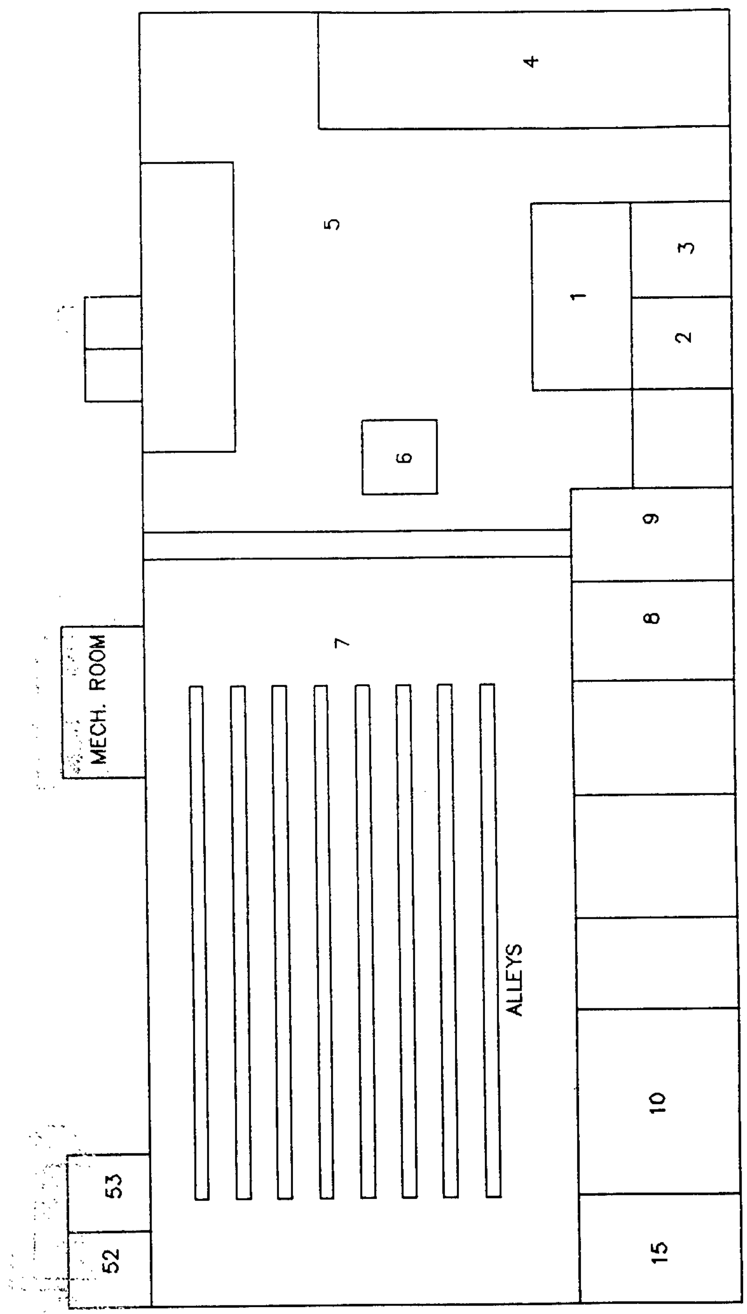


FLOOR PLAN
NTS

[366.DWG]

EMC PROJECT # 3105.000
SHEET __ OF __
FT. MC PHERSON BLDG. 401



FLOOR PLAN
NTS

[401.DWG]